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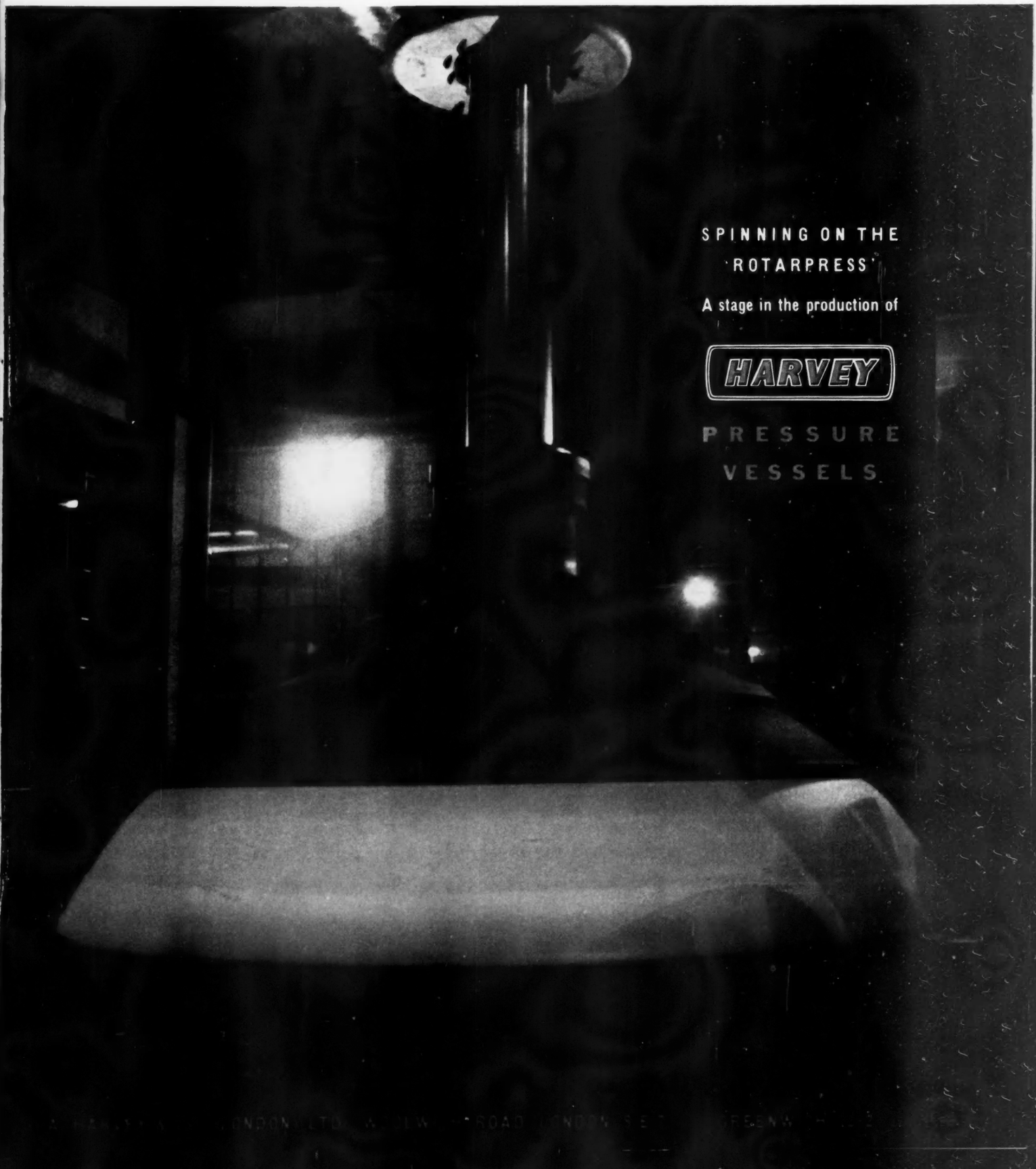

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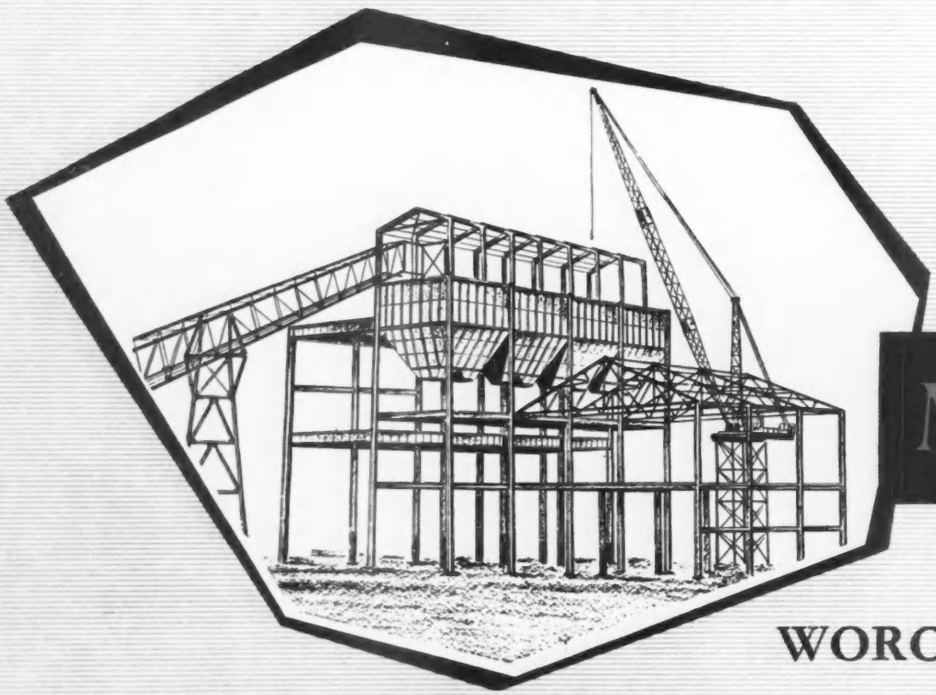

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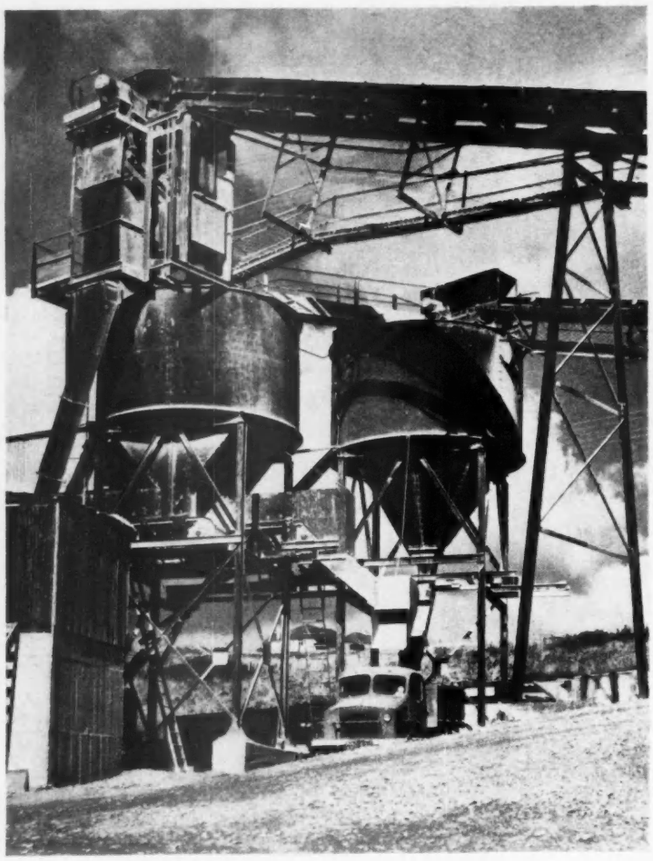

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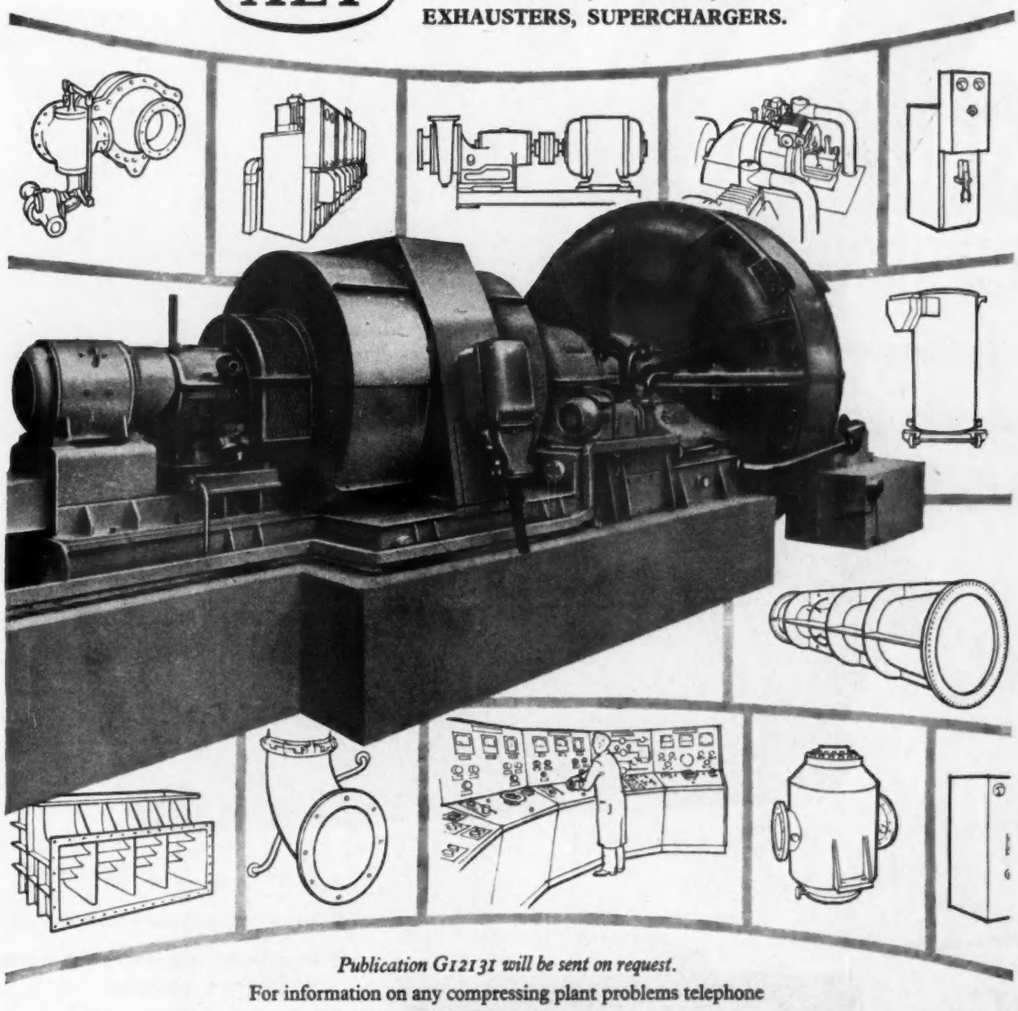

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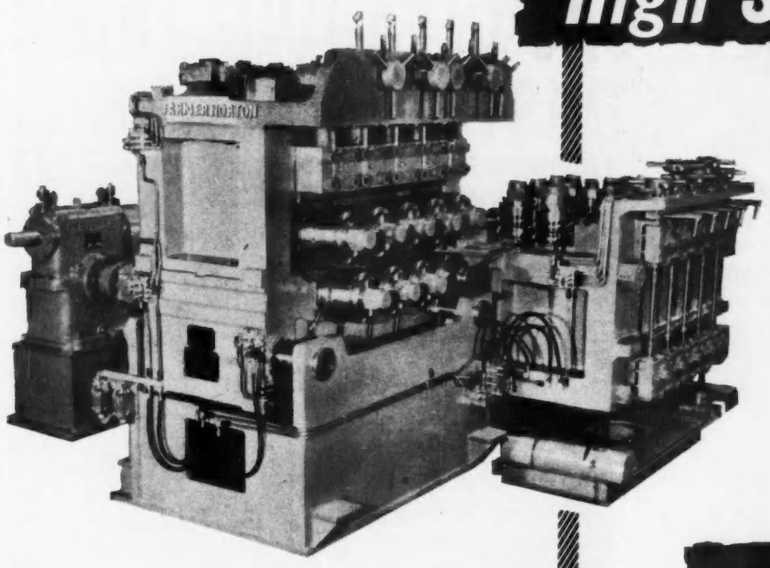

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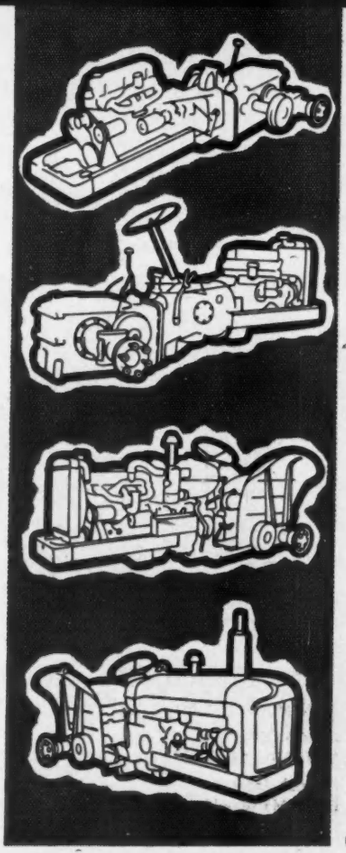

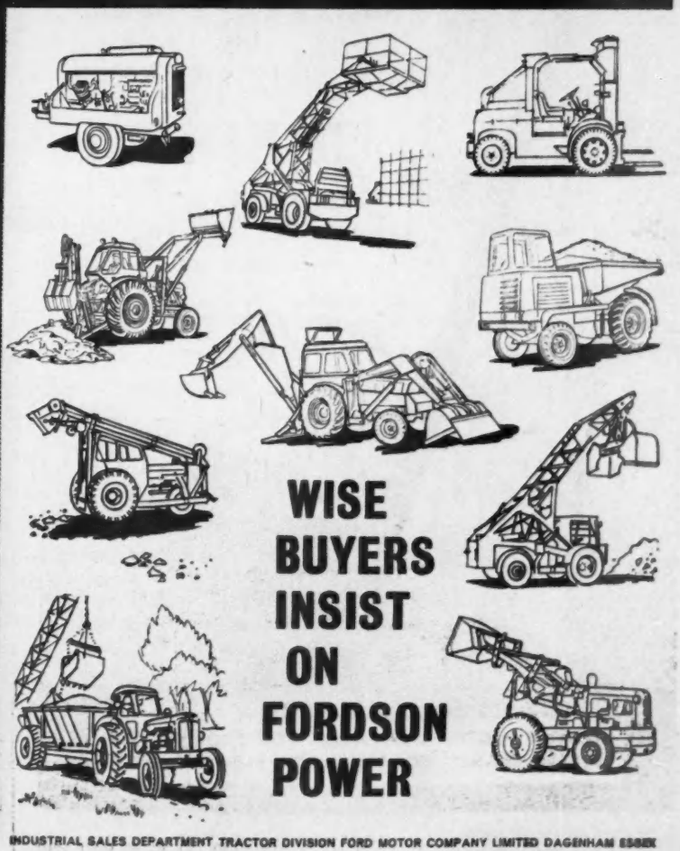

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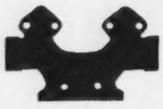

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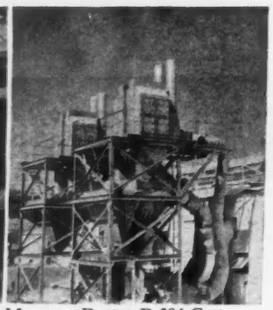

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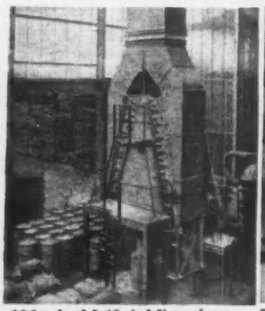

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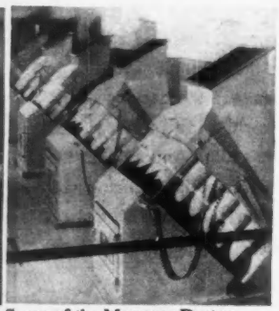

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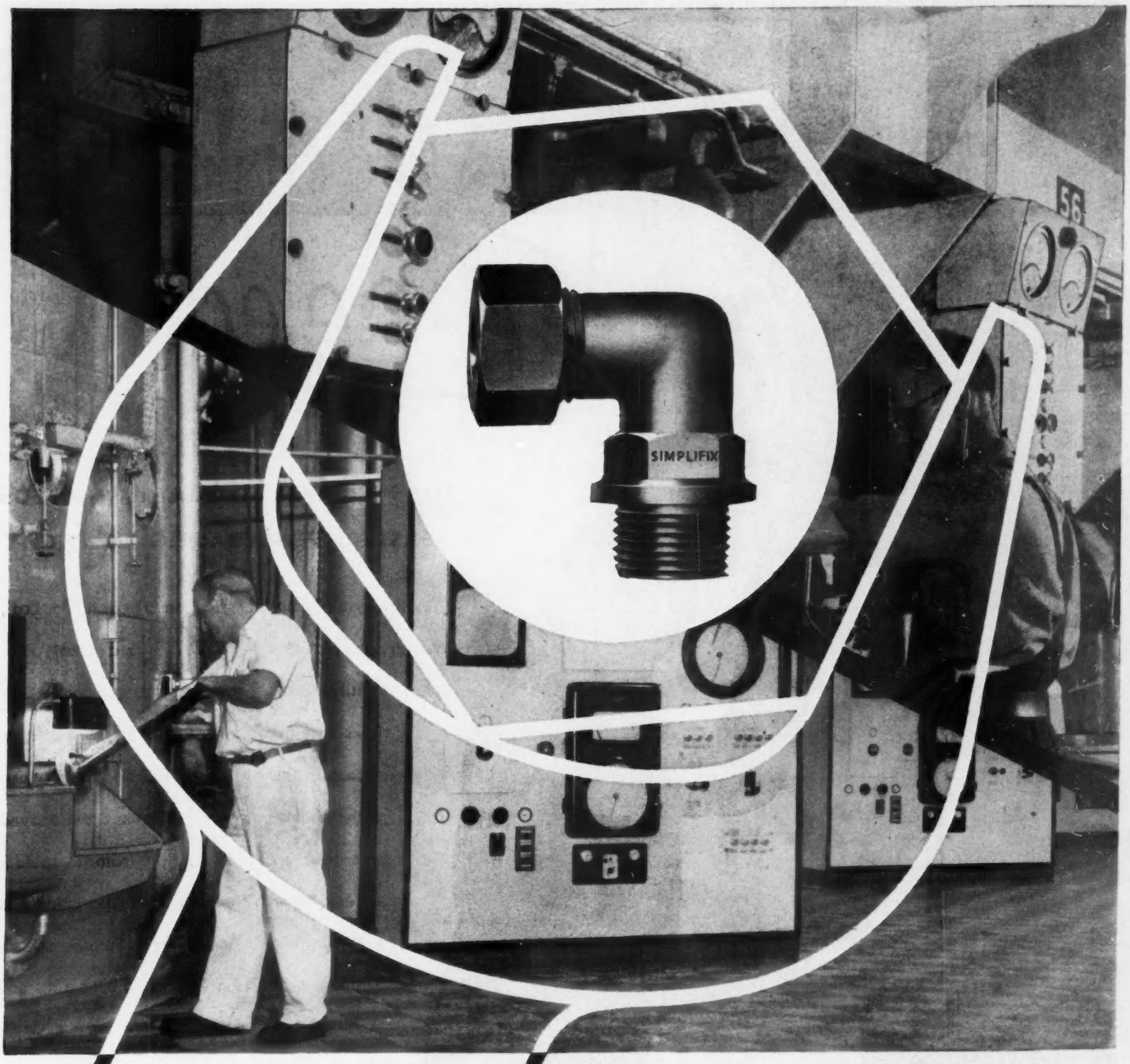

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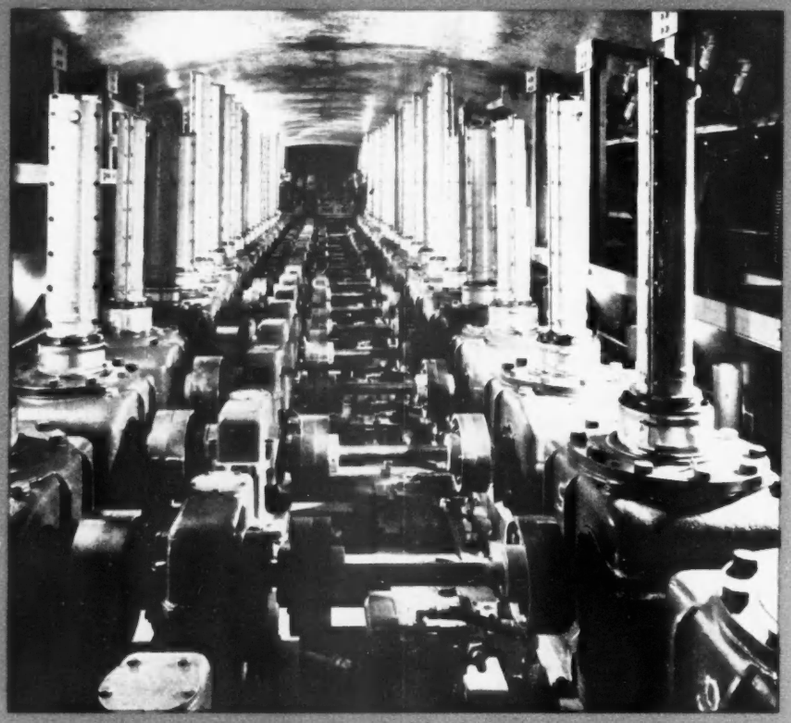

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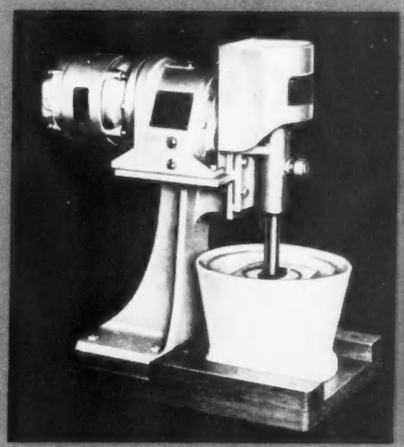

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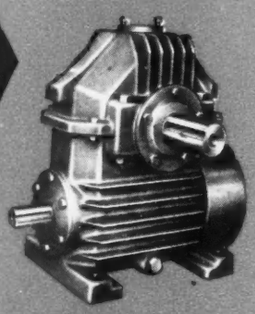

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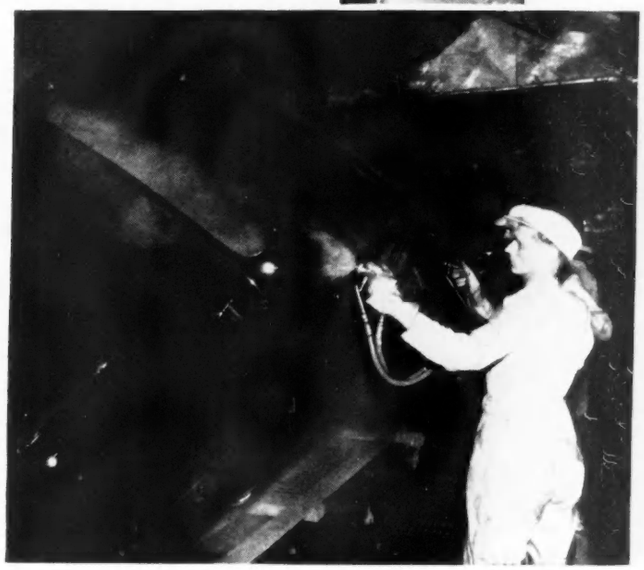

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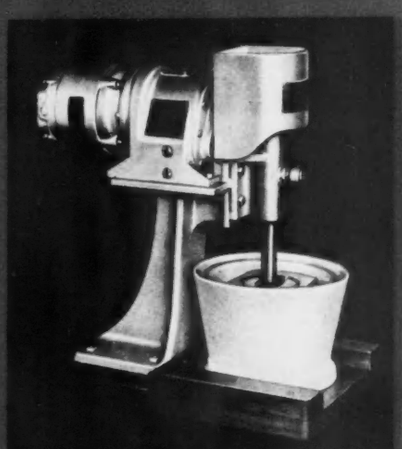

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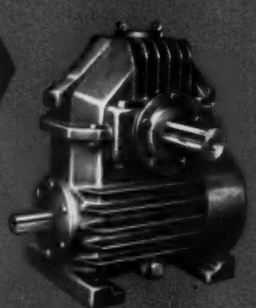

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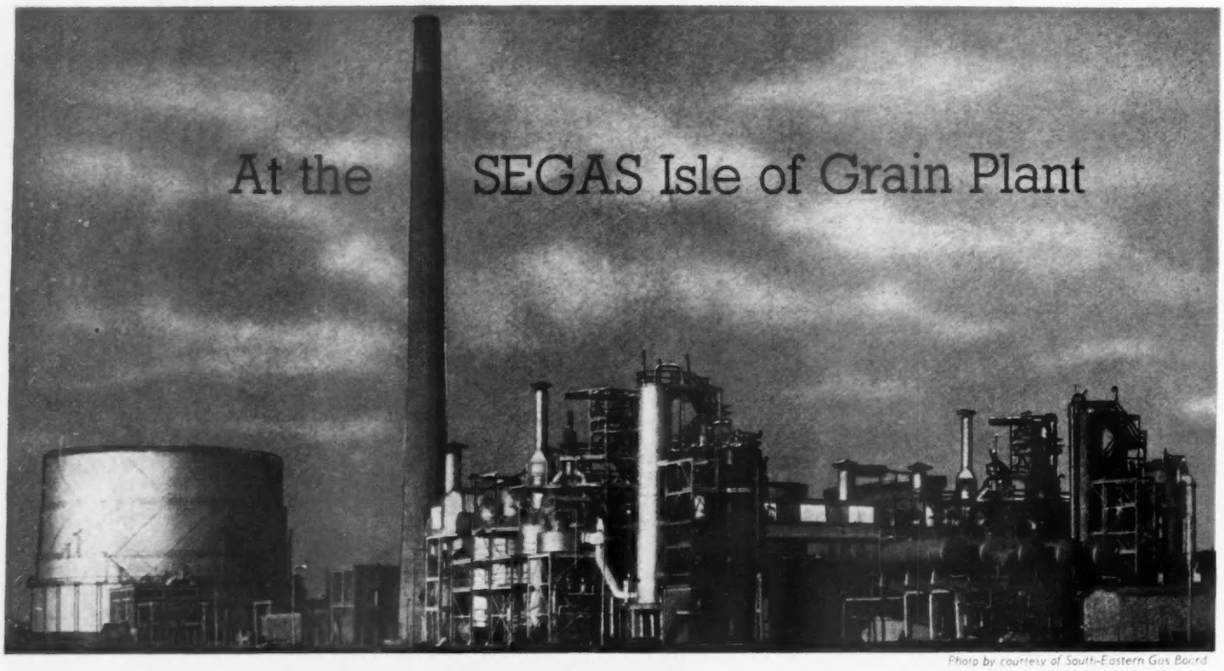
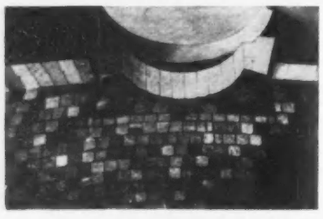


Photo by courtesy of South-Eastern Gas Board

R.B.HILTON installed the refractory linings

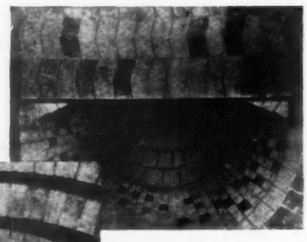


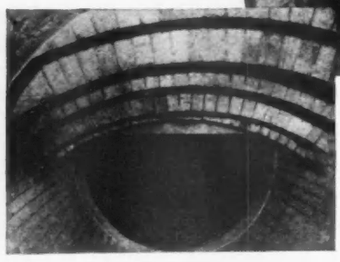
Access hole blocks

Gas from oil at the new Segas Isle of Grain plant is the latest development in British fuel production. A high standard of refractory brickwork is called for in the lining of these ducts and the installation of the arches and domes. Both workmanship and materials must be of the highest quality.

R. B. Hilton Limited carried out the work using materials supplied by General Refractories Ltd. A team of experienced craftsmen worked under the supervision of the Area Manager and the personal scrutiny of one of the company's directors.

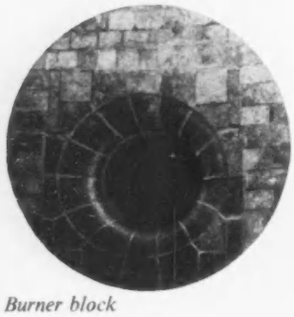
Further details of Hilton's services will gladly be provided on request.





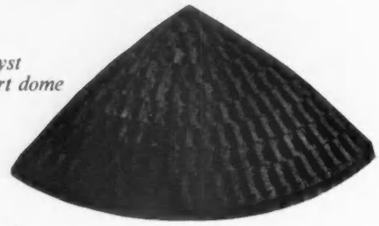
"V" Block Arch blocks

Stepped arches



Burner block

Catalyst support dome



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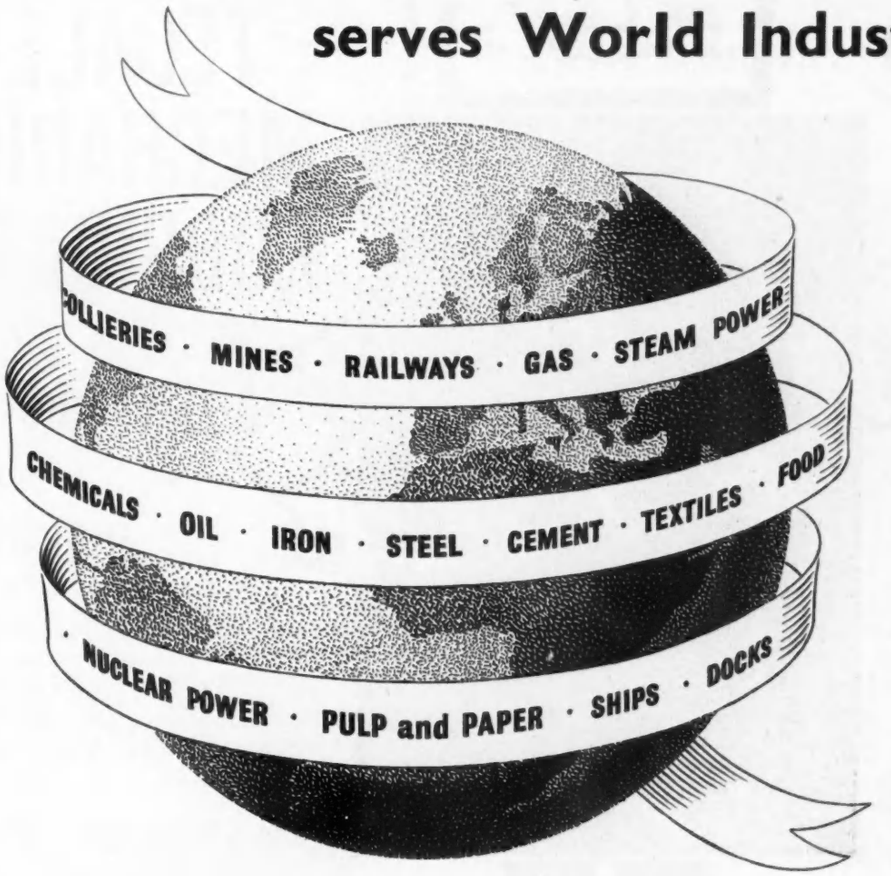
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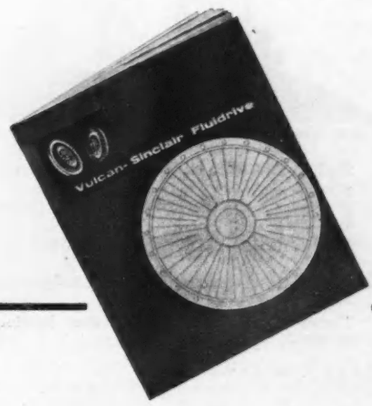

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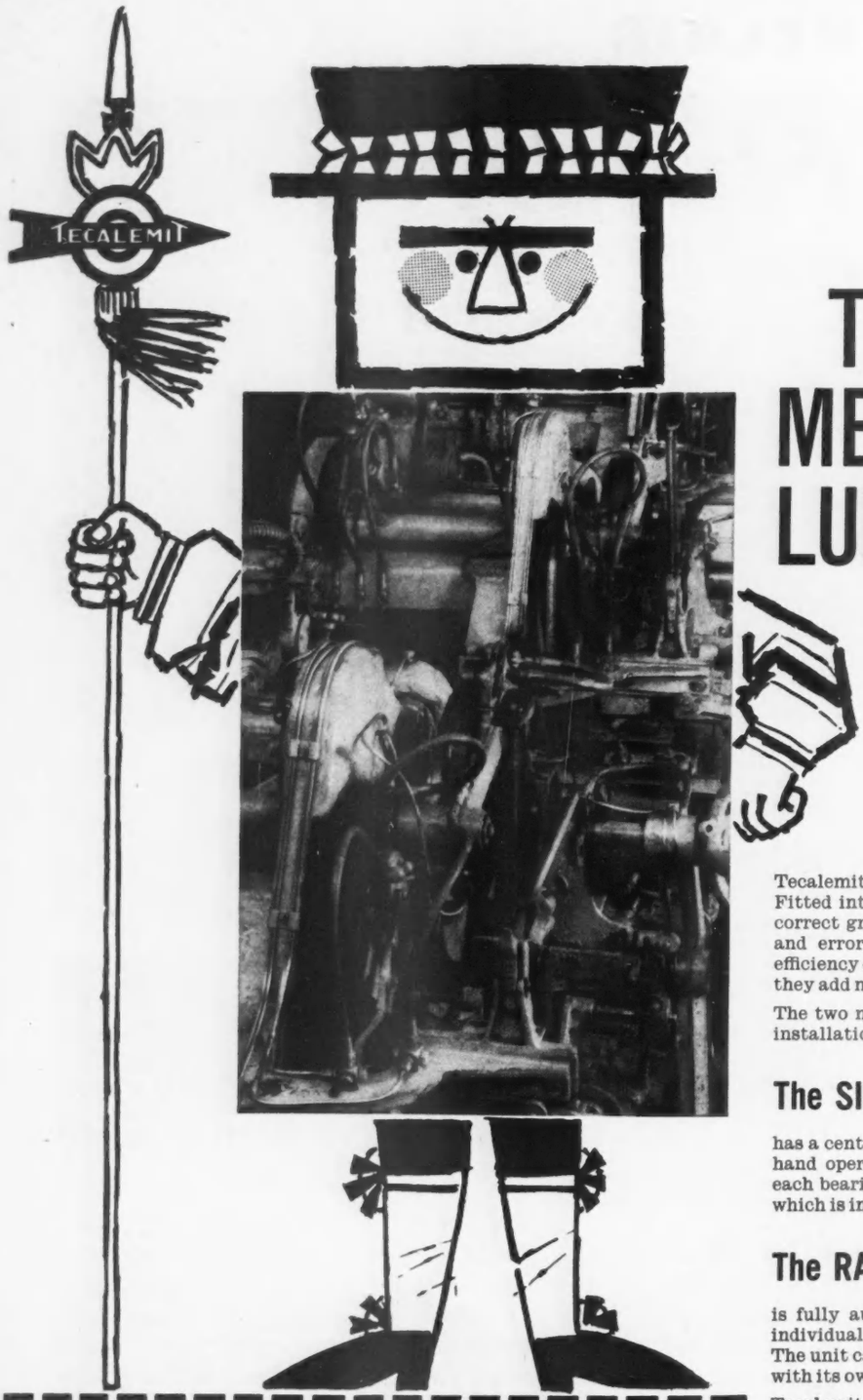

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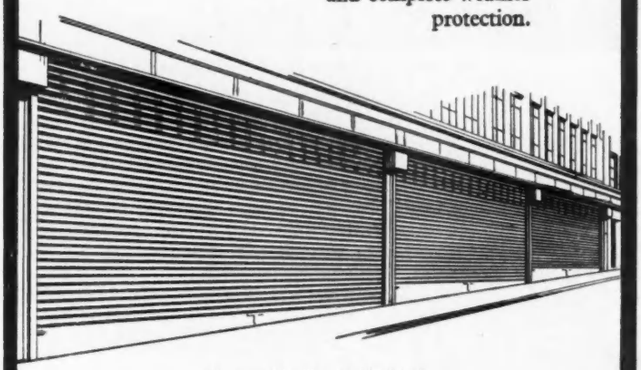

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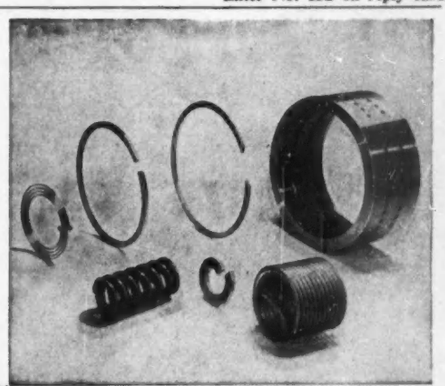

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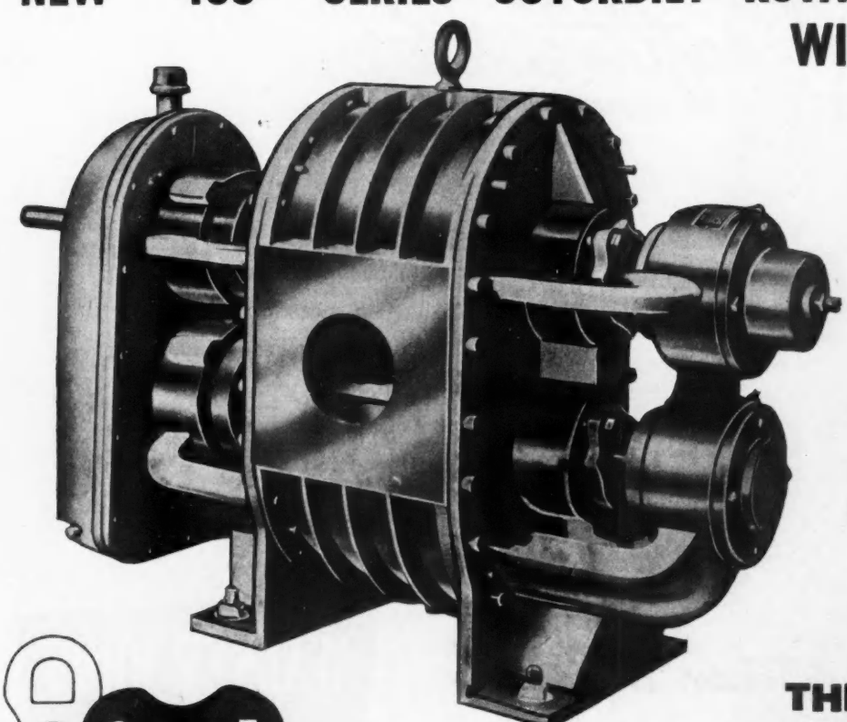

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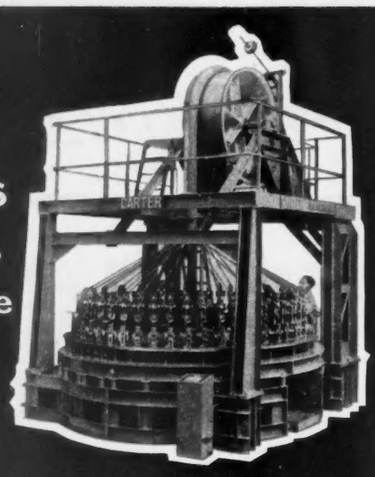

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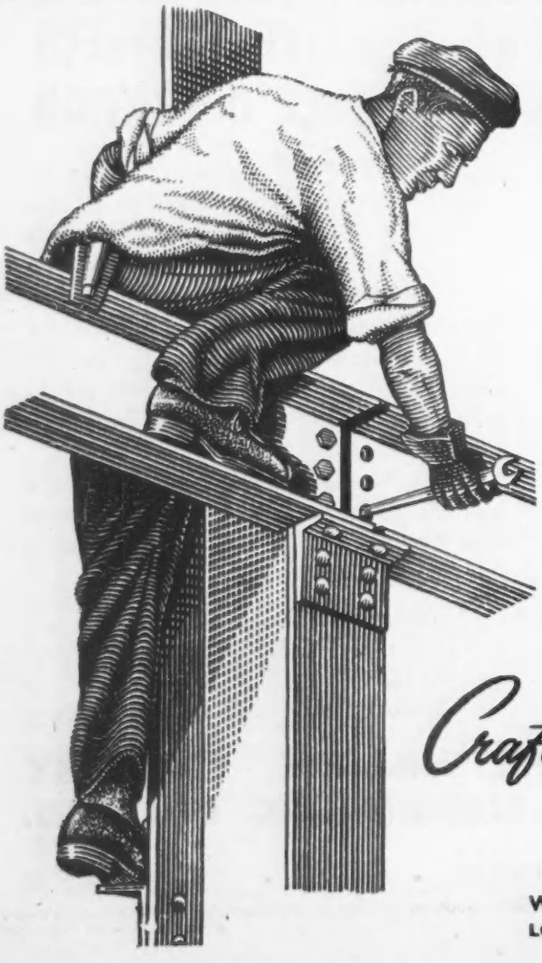

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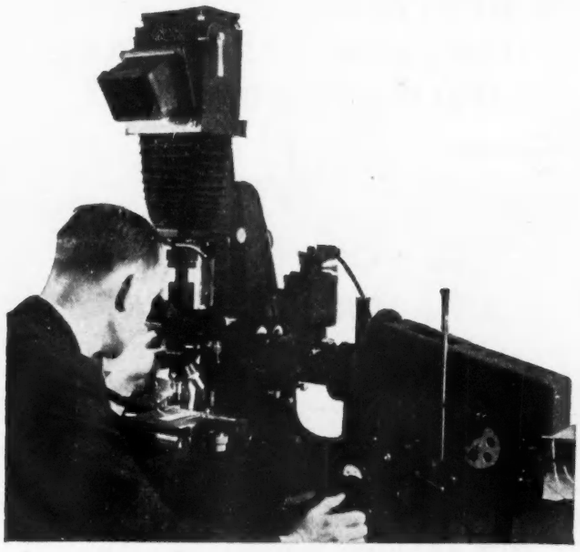

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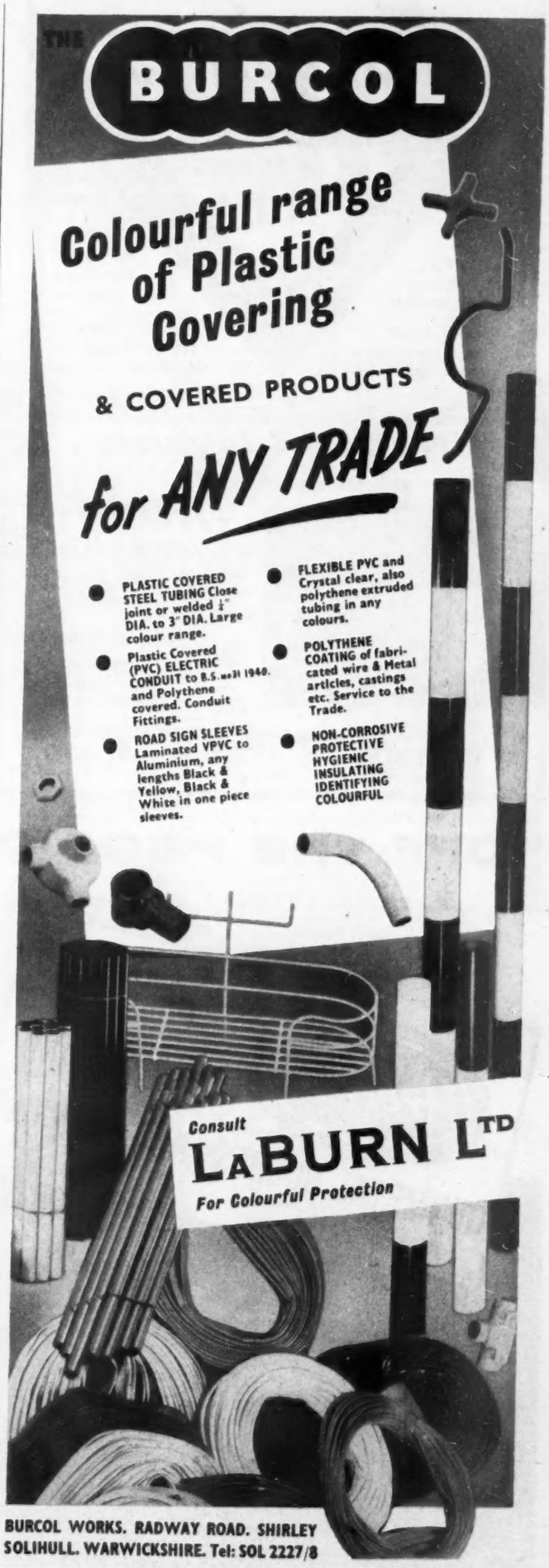

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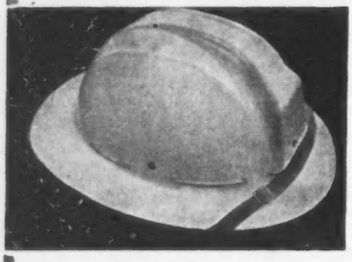

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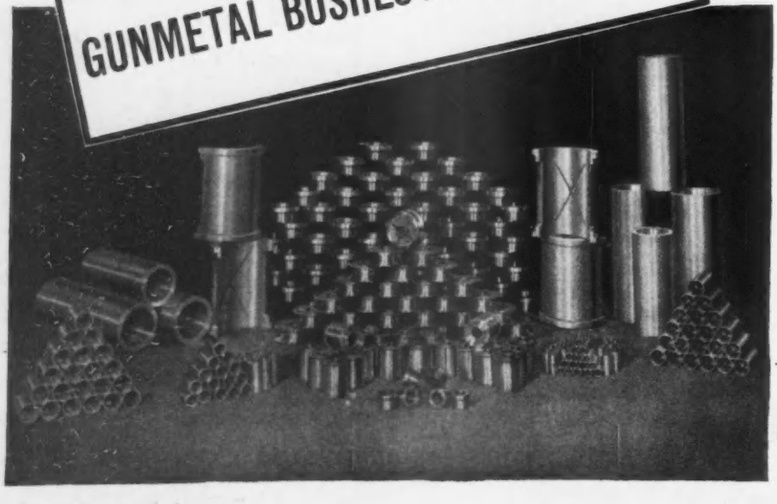

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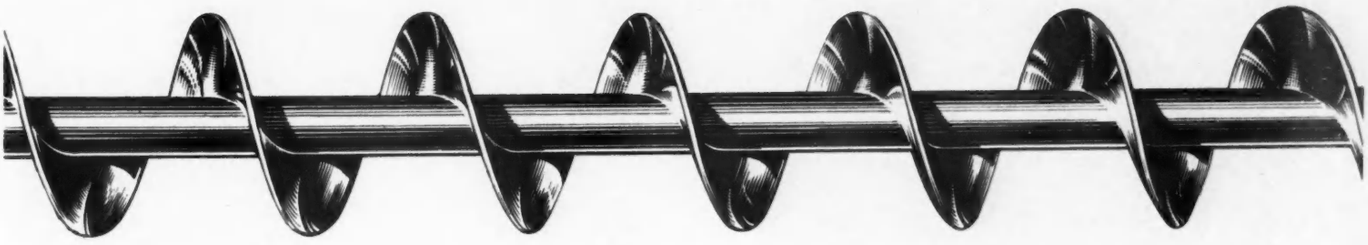

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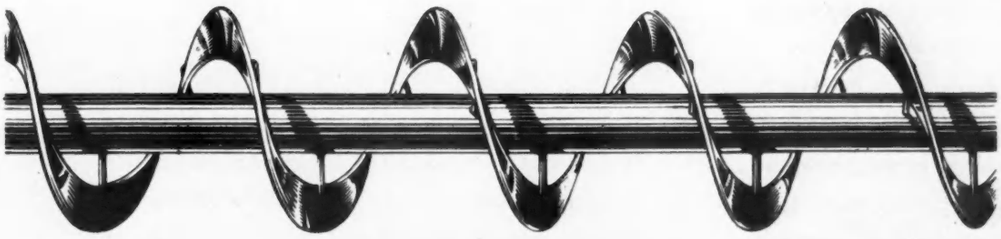

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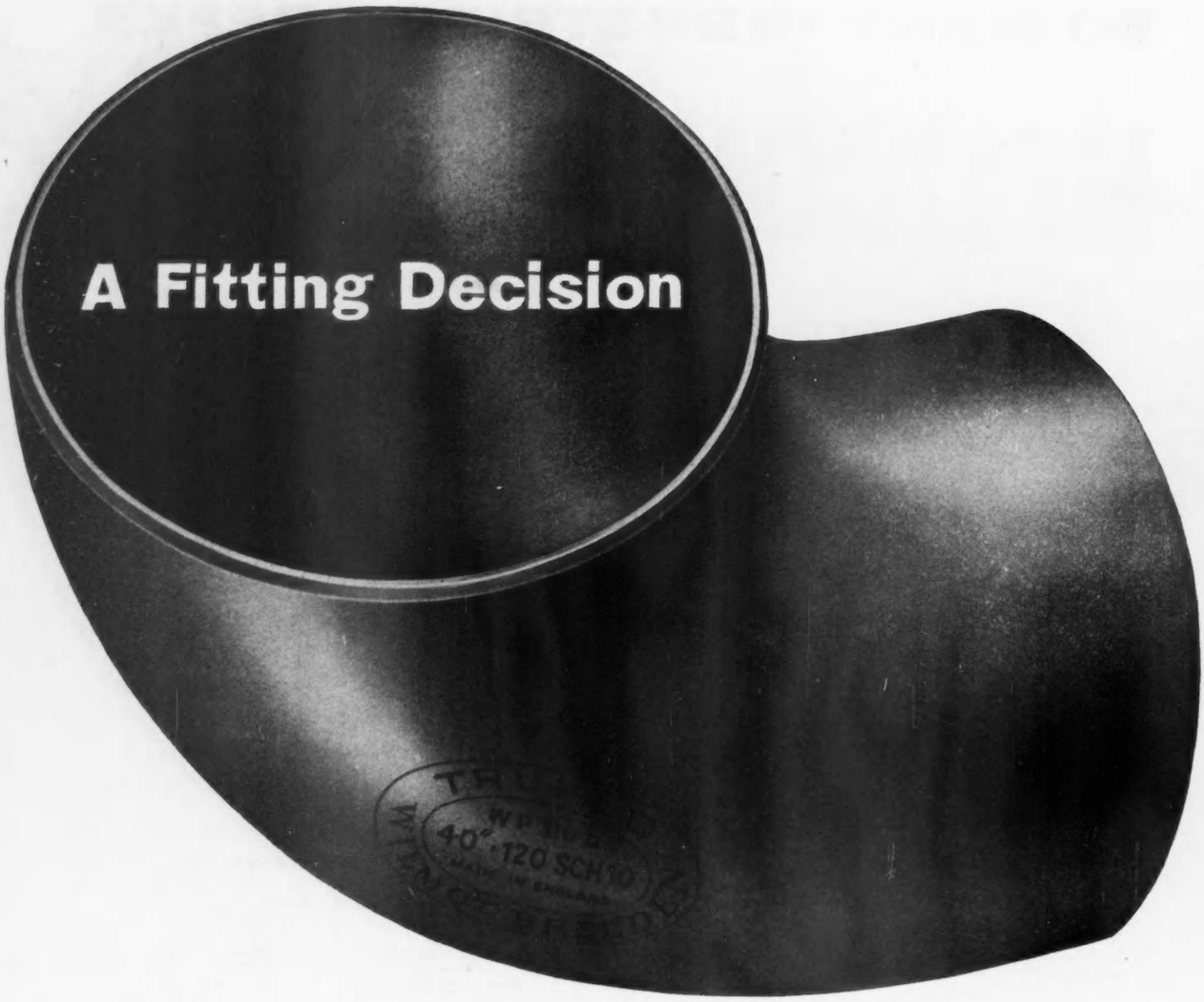

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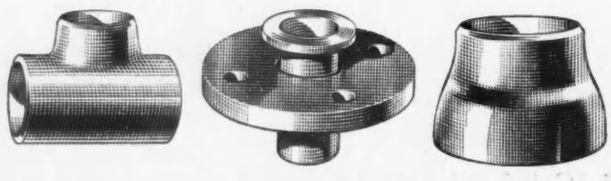

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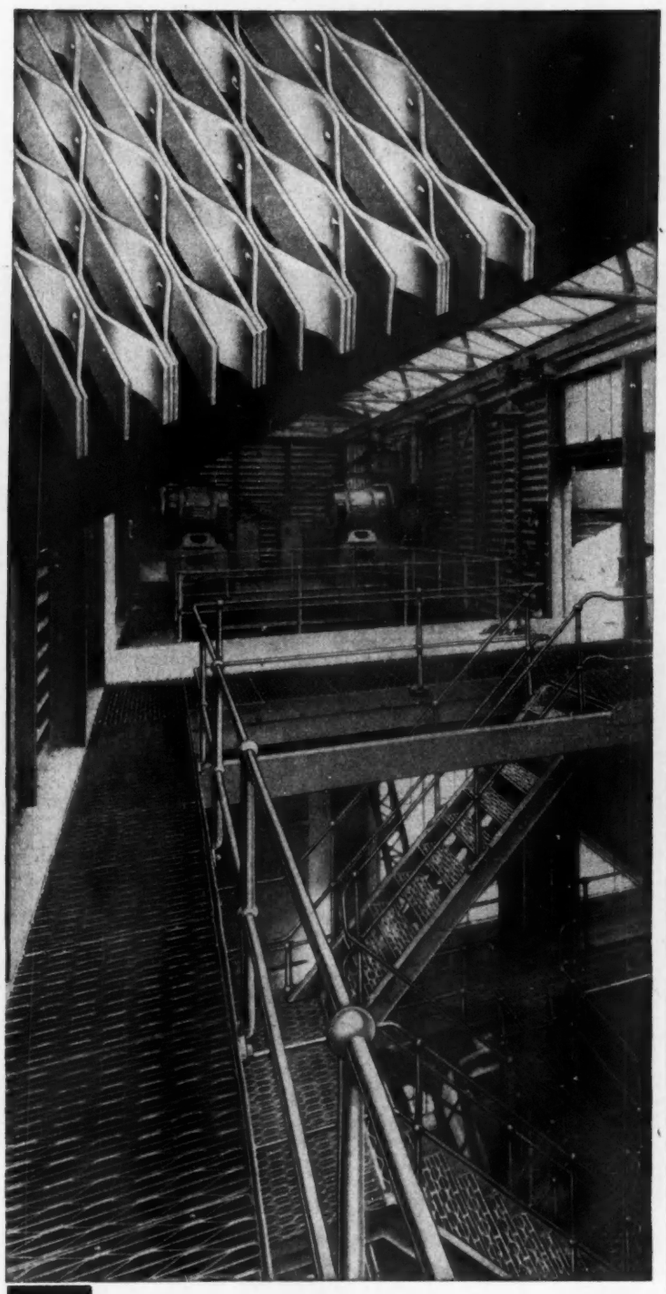

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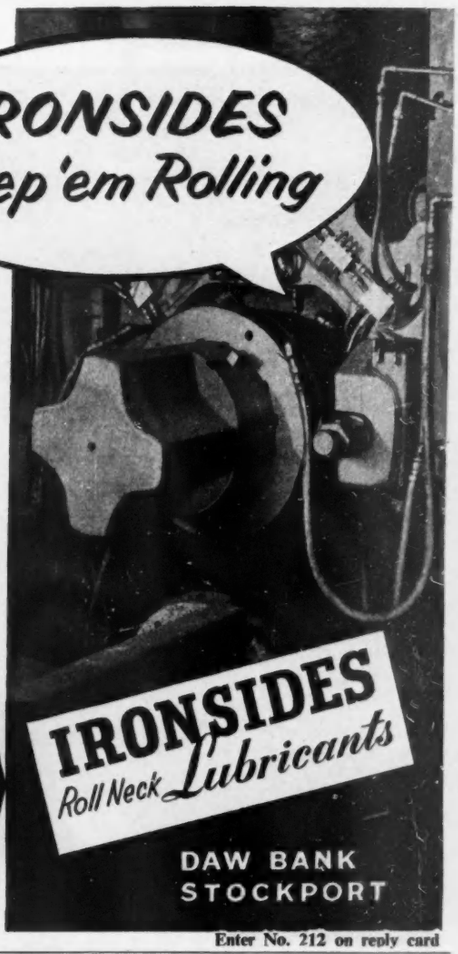

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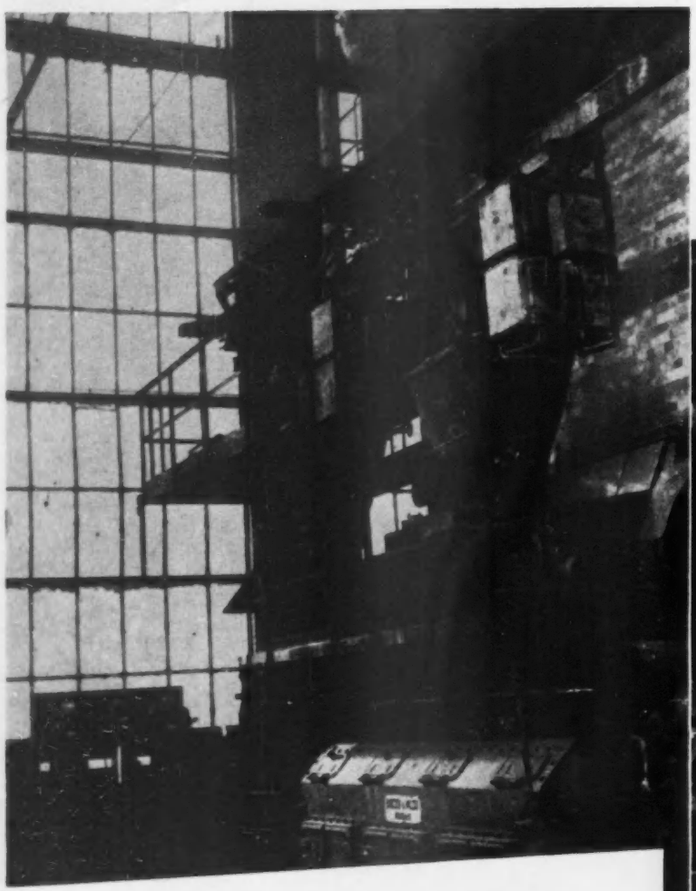

BOILERS
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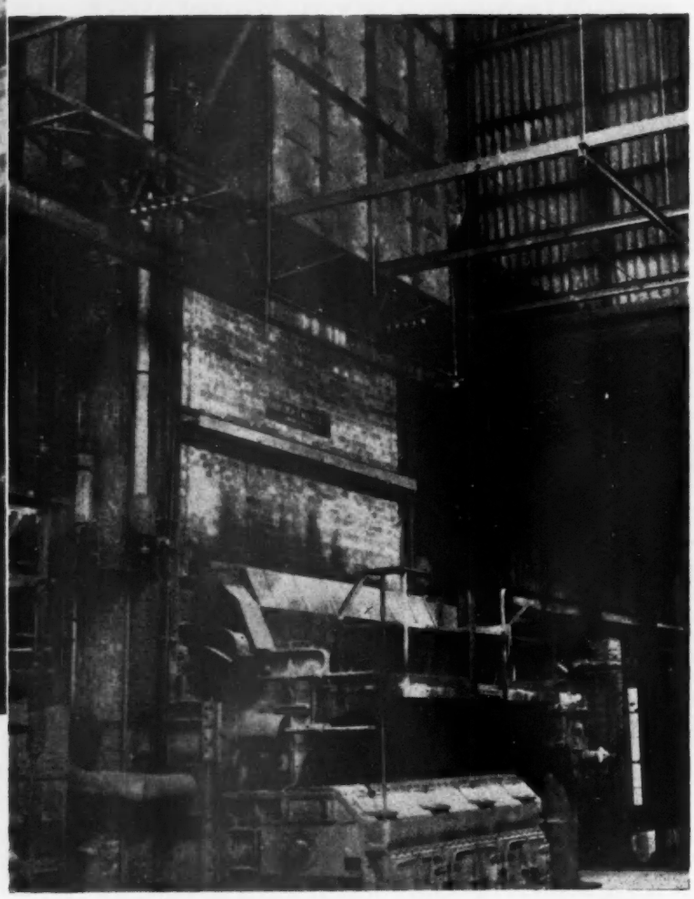

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ALSO AVAILABLE

EIGHT **Edwin Danks** LANCASHIRE BOILERS, dish ended, 30ft. long×9ft. 3in. diameter, working pressure 160 p.s.i.g. Approximate evaporation 10,200 lb./hr., from and at 212 deg. Fah., 8,500 lb./hr. with feed at 60 deg. Fah. when hand fired. Alternatively approximately 12,250 lb/hr. from and at 212 deg. Fah., 10,200 lb./hr. with feed at 60 deg. Fah. when stoker fired.

TWO **Babcock & Wilcox** type W.I.F. WATERTUBE BOILERS, each having two drums self-supported in steelwork ; each having a heating surface of 3,654 sq. ft., 18,750 lb./hr. evaporation from and at 212 deg. Fah., working pressure 212 p.s.i.g. With superheater.

Babcock & Wilcox WATERTUBE BOILER, having two drums and self-supporting steelwork ; heating surface 4,394 sq. ft., designed evaporation 22,000 lb./hr. from and at 212 deg. Fah., working pressure 212 p.s.i.g. With superheater.

TWO **Cochran** " Sinuflo " double-pass ECONOMIC BOILERS, 10ft. 9in. diameter×15ft. 8in. over tubeplates, 22ft. 7in. overall length. Working pressure 120 p.s.i., evaporation 16,800/18,000 lb. hr. approx. from and at 212 deg. Fah.

Adamson horizontal double-pass ECONOMIC BOILER, 10ft. 6in. diameter×16ft. over tubeplates, 20ft. 8in. overall length. Working pressure 160 p.s.i.g., evaporation 14,400 lb./hr. from and at 212 deg. Fah.

John Thompson horizontal treble-pass SUPER ECONOMIC BOILER, 9ft. 6in. diameter×14ft. over tubeplates, 19ft. overall length. Working pressure 125 p.s.i.g., evaporation approximately 14,500 lb./hr. from and at 212 deg. Fah.

Cochran Size No. 21 VERTICAL MULTI-TUBULAR BOILER, 8ft. diameter×16ft. 6in. high. Working pressure 105 p.s.i.g., approximate evaporation 5,200 lb./hr. normal from and at 212 deg. Fah.

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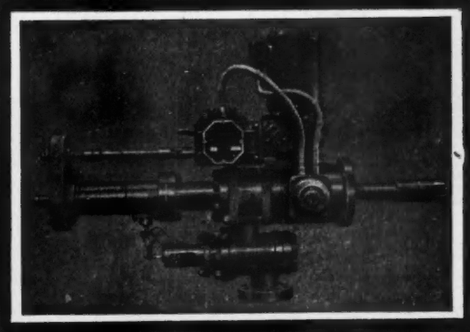
Further information is given in our publication No. CBL. 1954 which will be supplied on application.



THE BLOWER: The complete operating cycle is in one motion and is driven through a compact mechanism by a non-reversing motor. When the operating shaft is rotated, the nozzle advances, the steam ports open and, at the same time, rocking motion is automatically transmitted to the nozzle. The uni-directional motor eliminates the bulky contactor gear used with reversing motors and reduces electrical maintenance by being of simpler and more rugged construction.

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AND THE CONTROL PANEL Simple controls to operate the automatic sequence are grouped on this small unit which takes up little space on the main boiler control panel.

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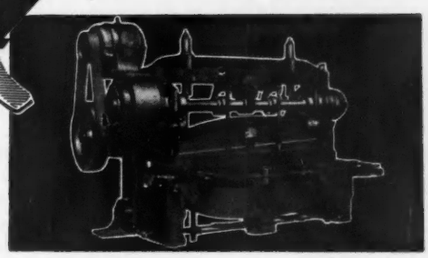

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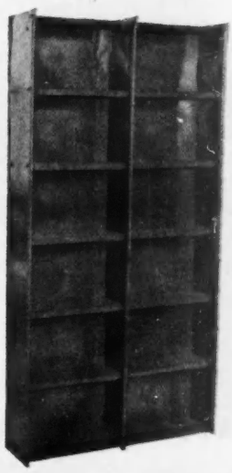

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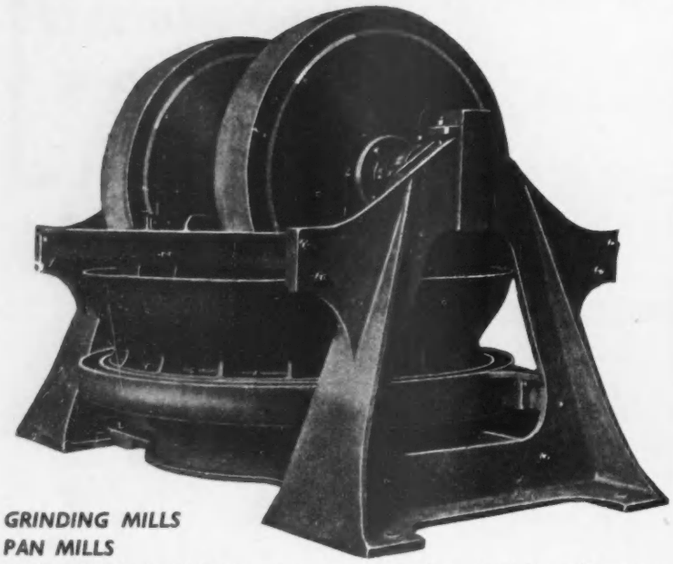

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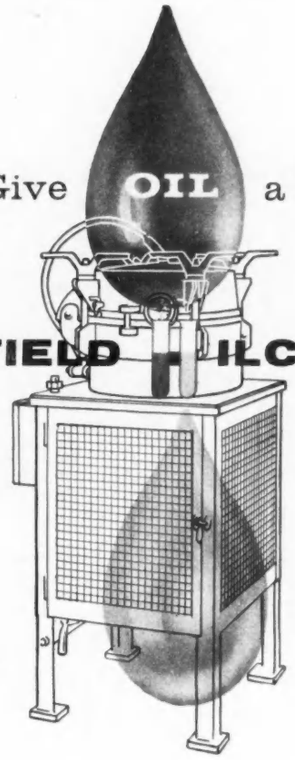

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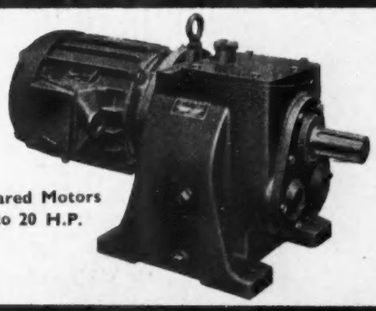

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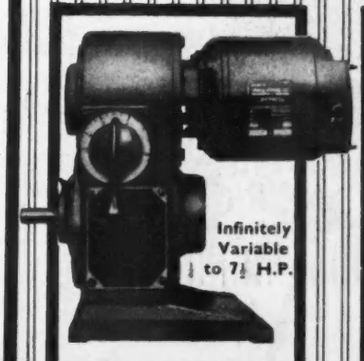

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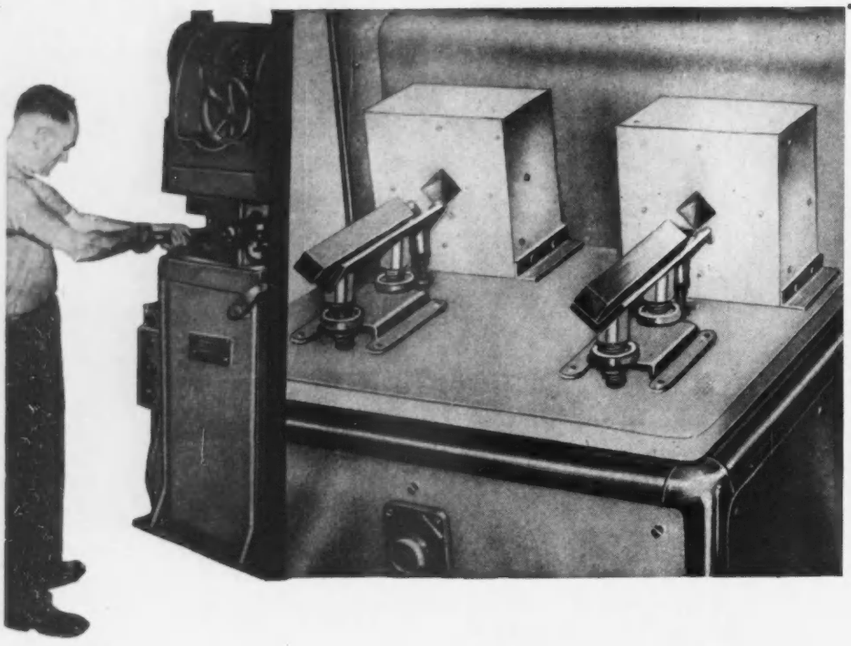

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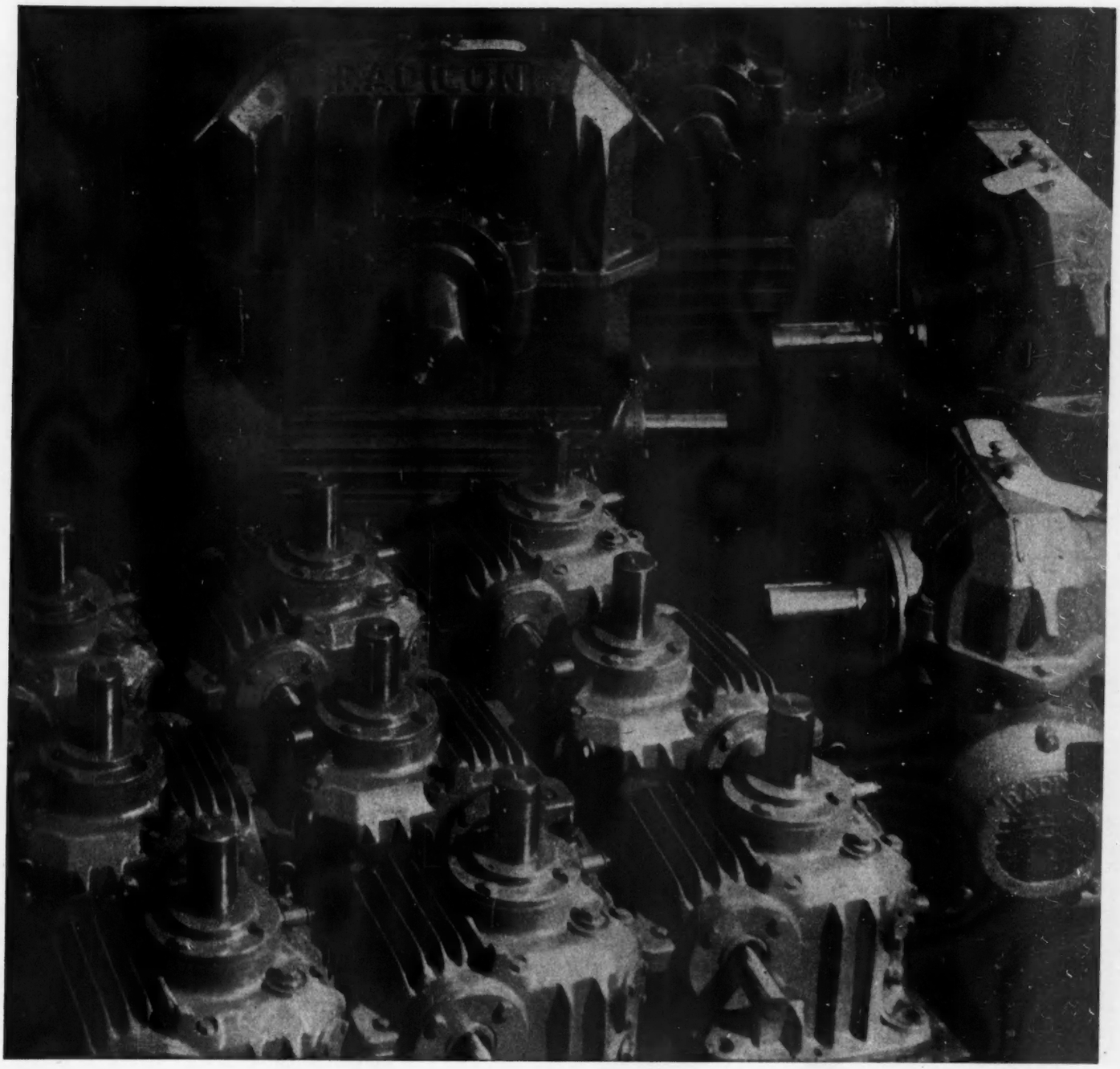

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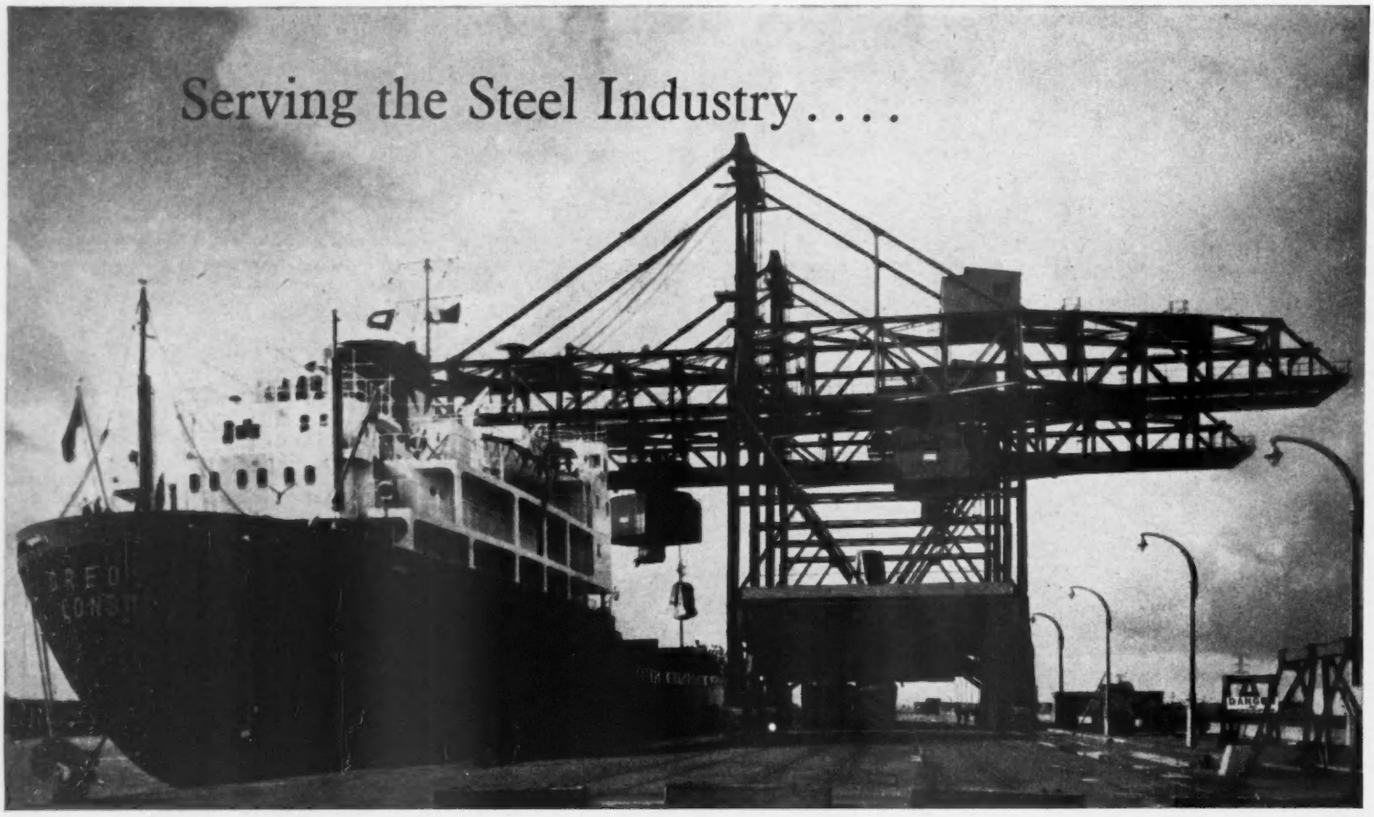

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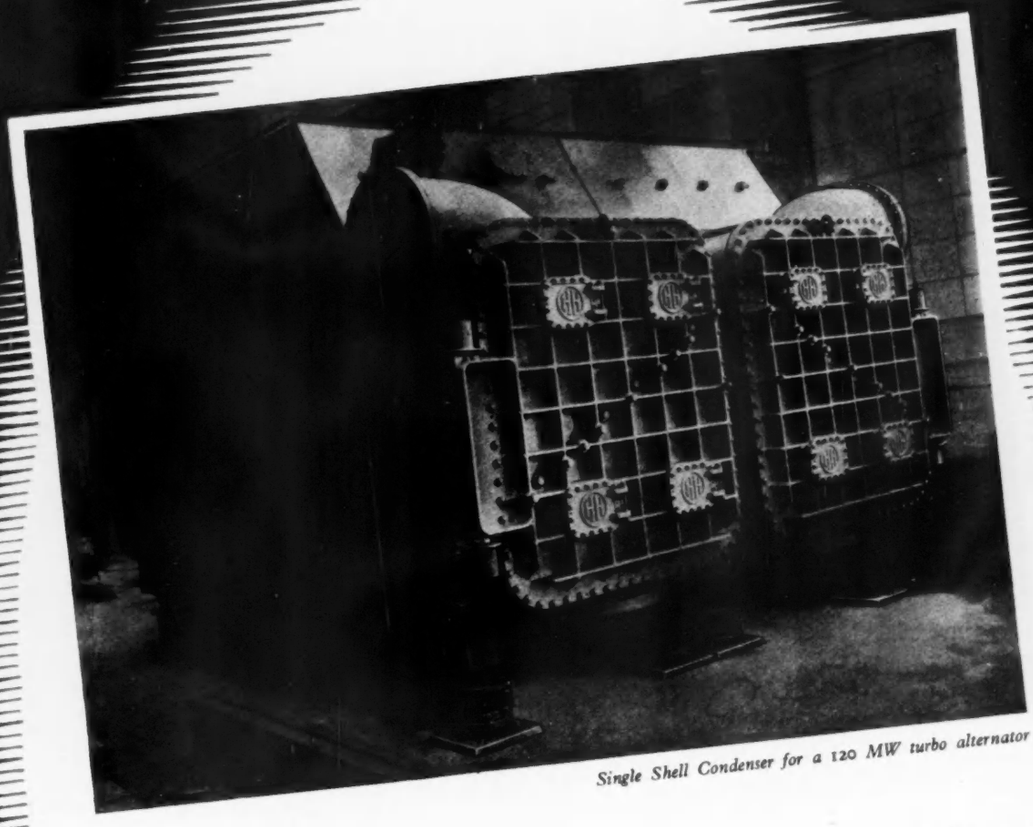

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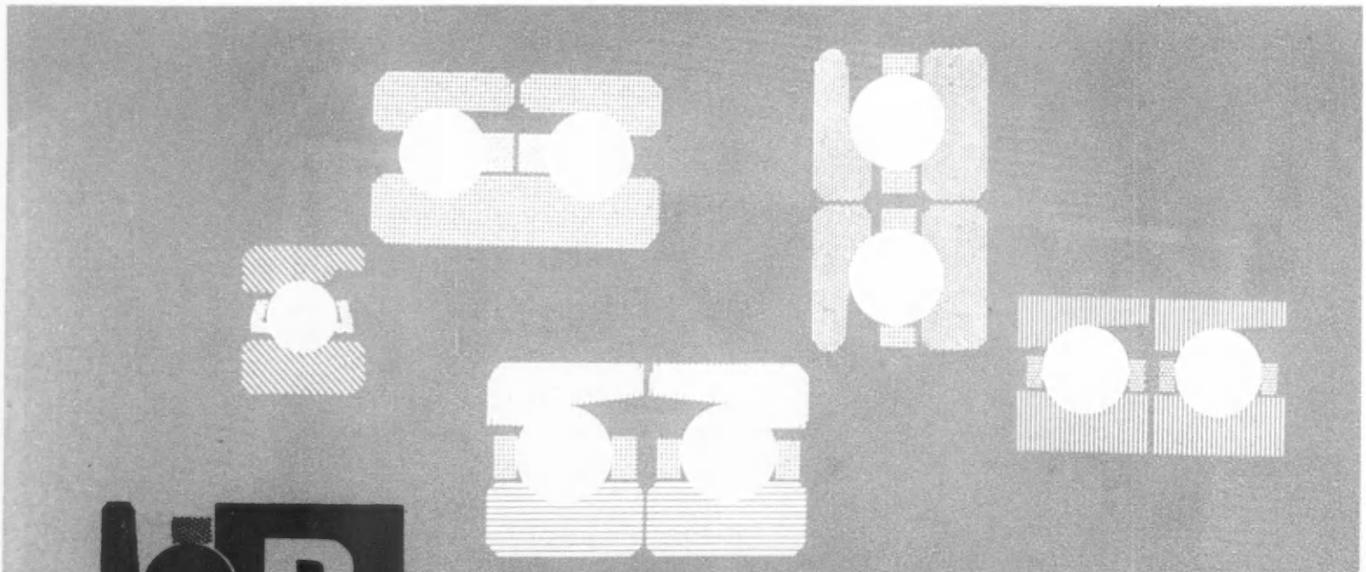

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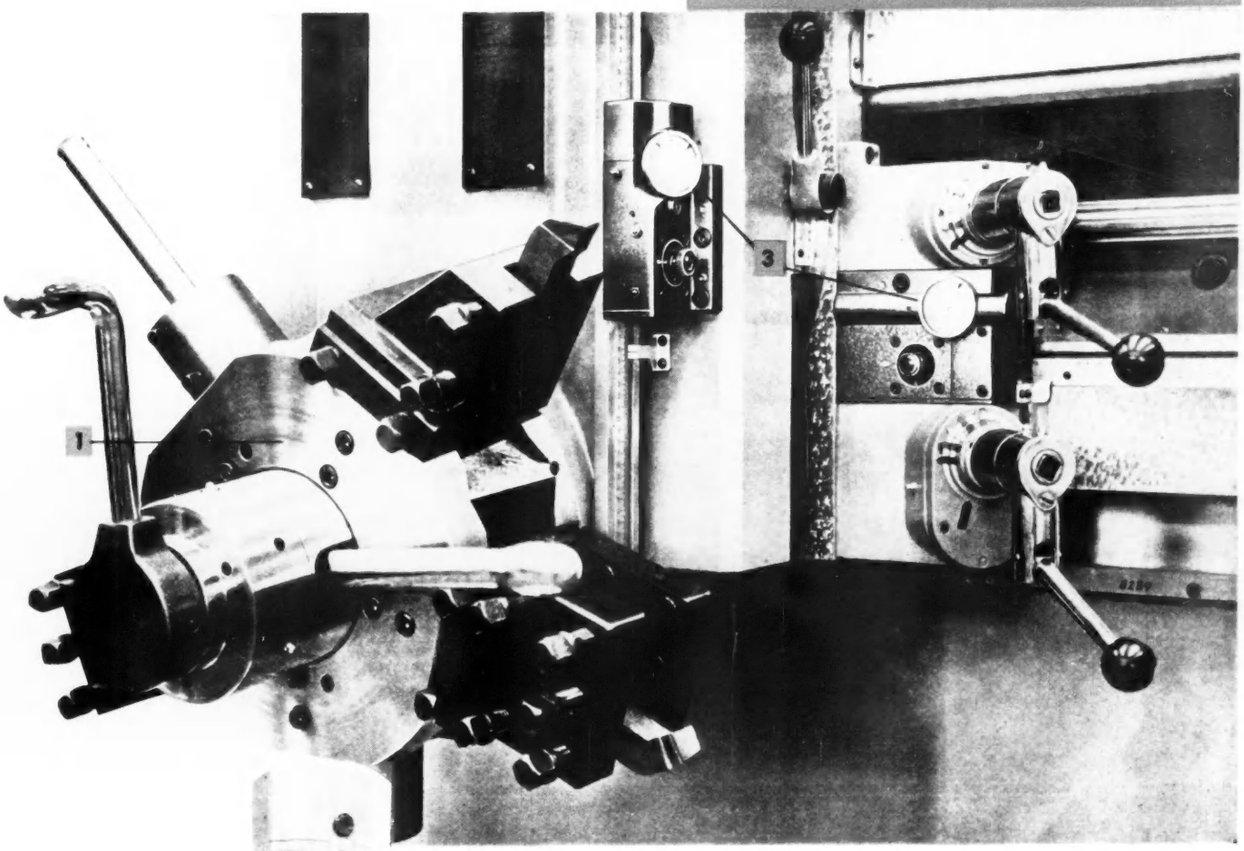

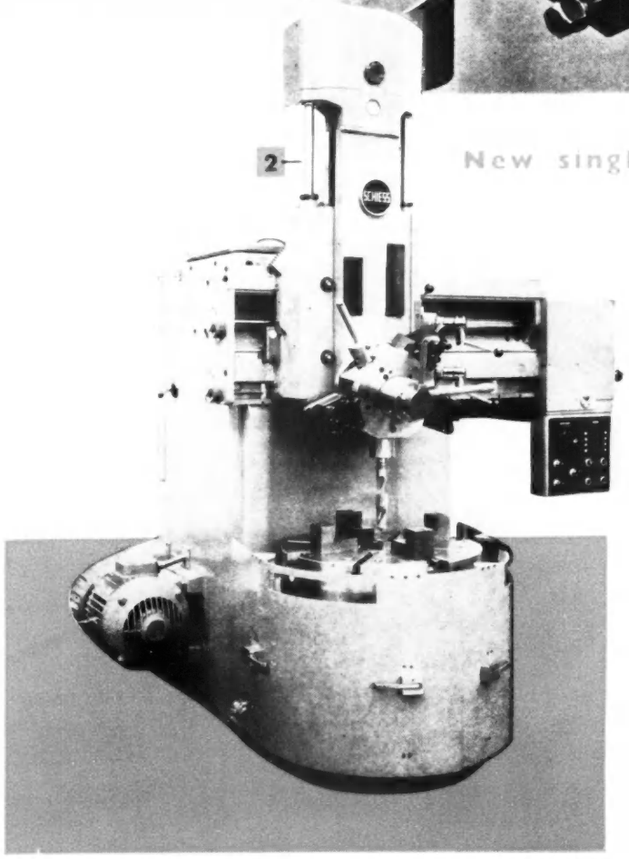

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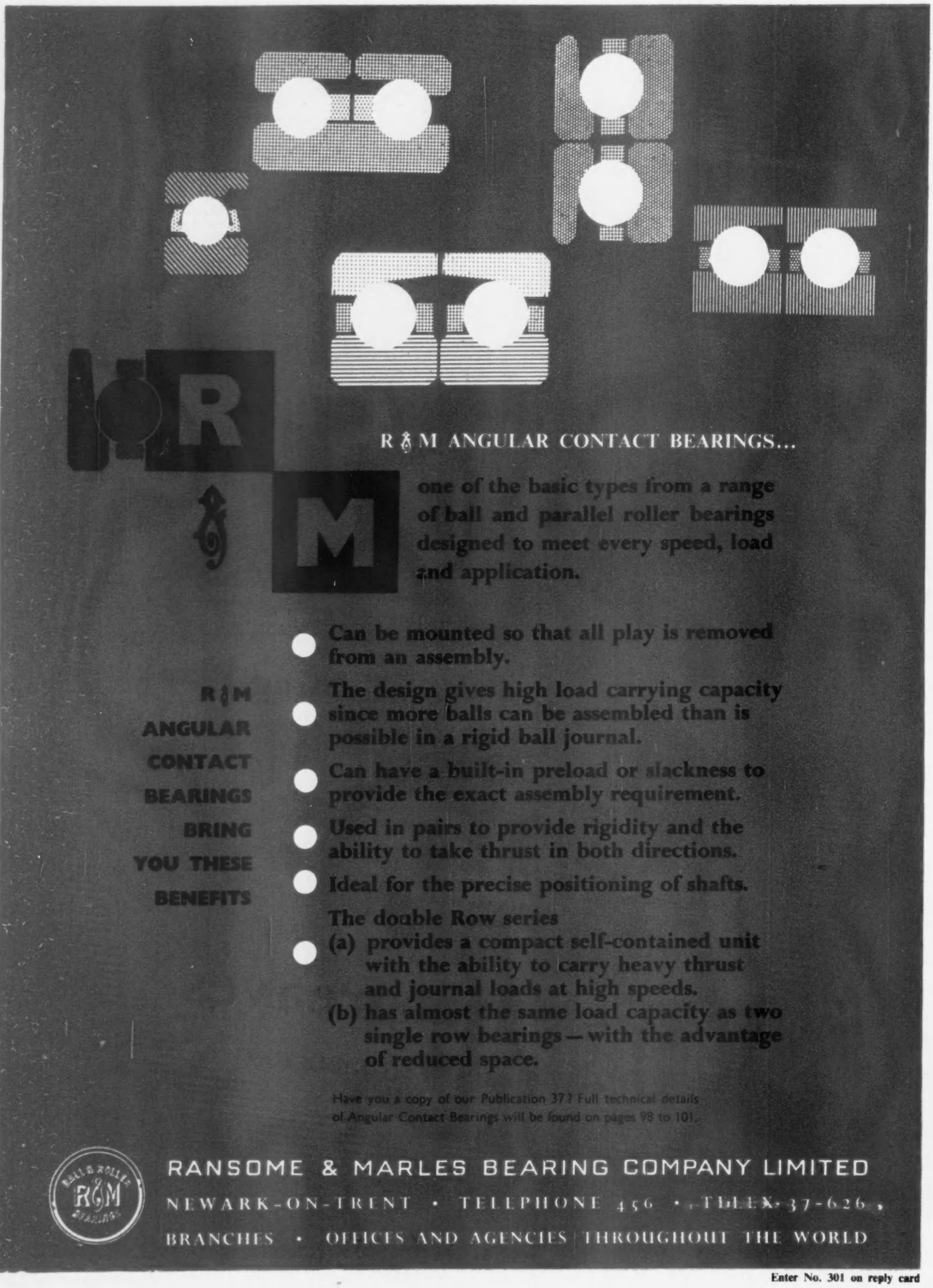
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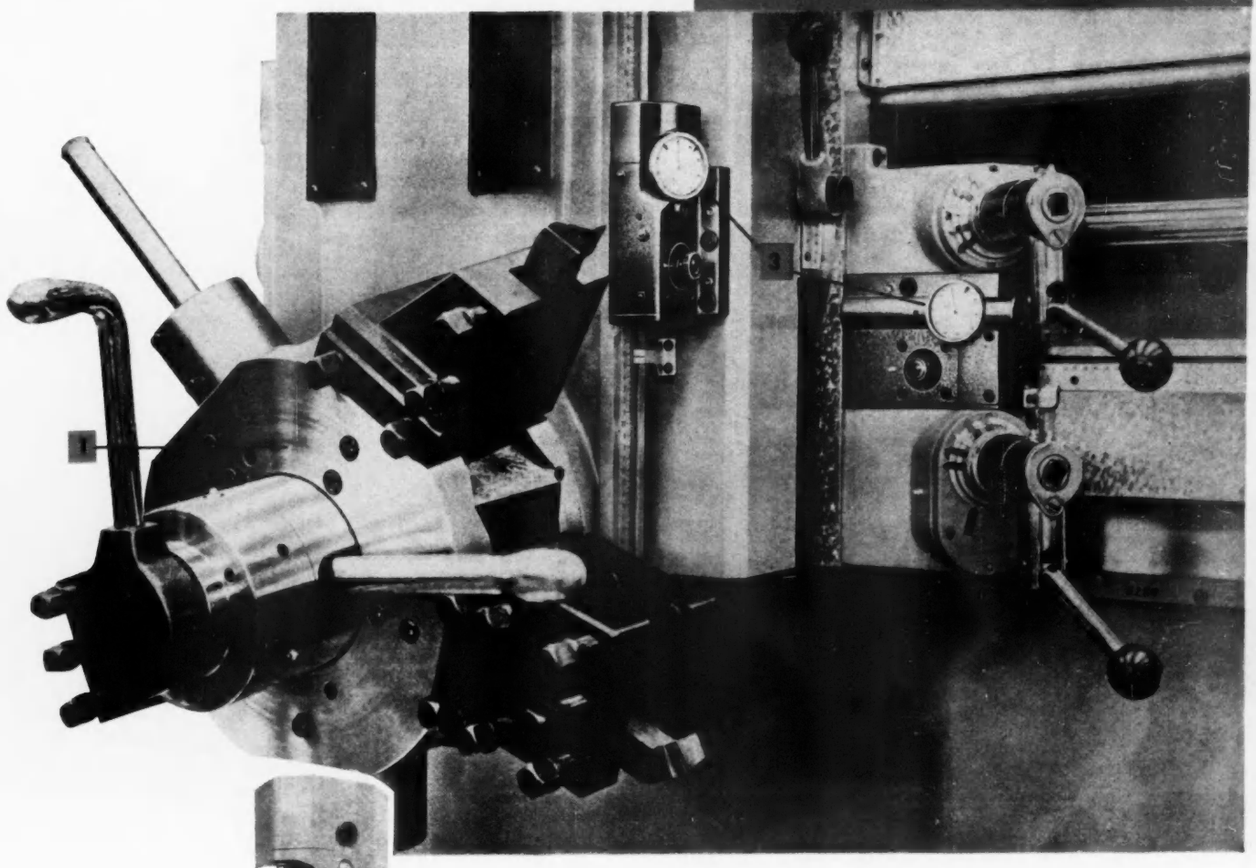

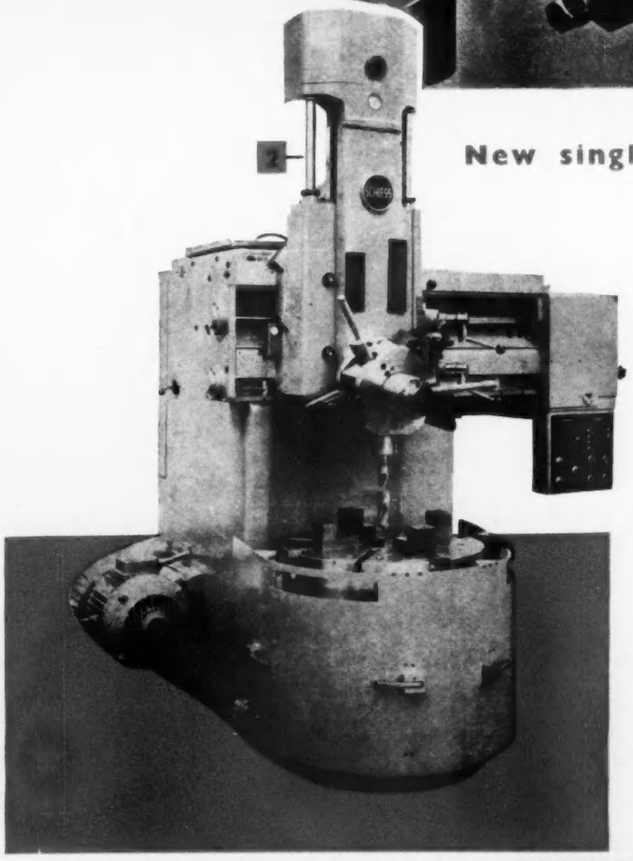

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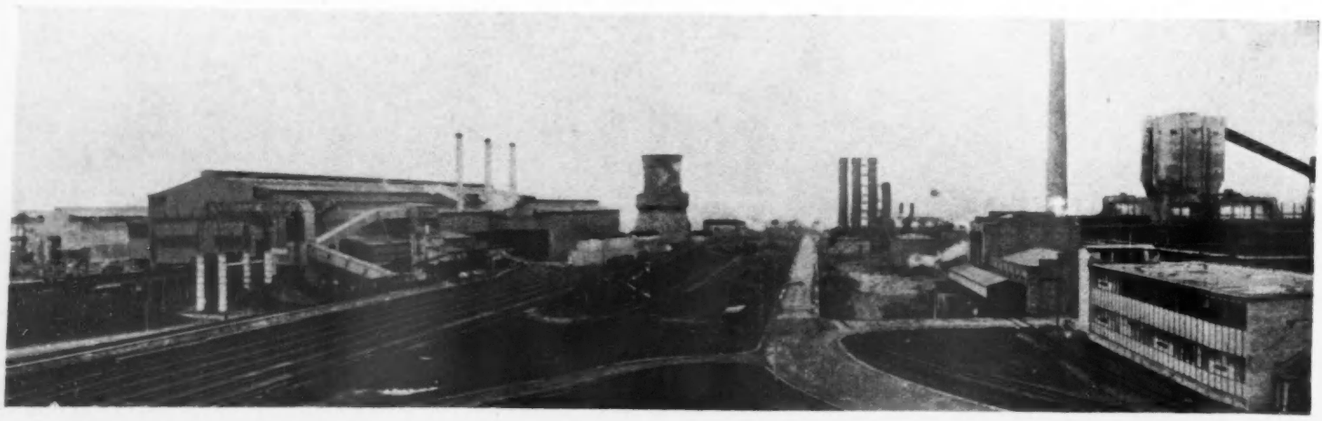

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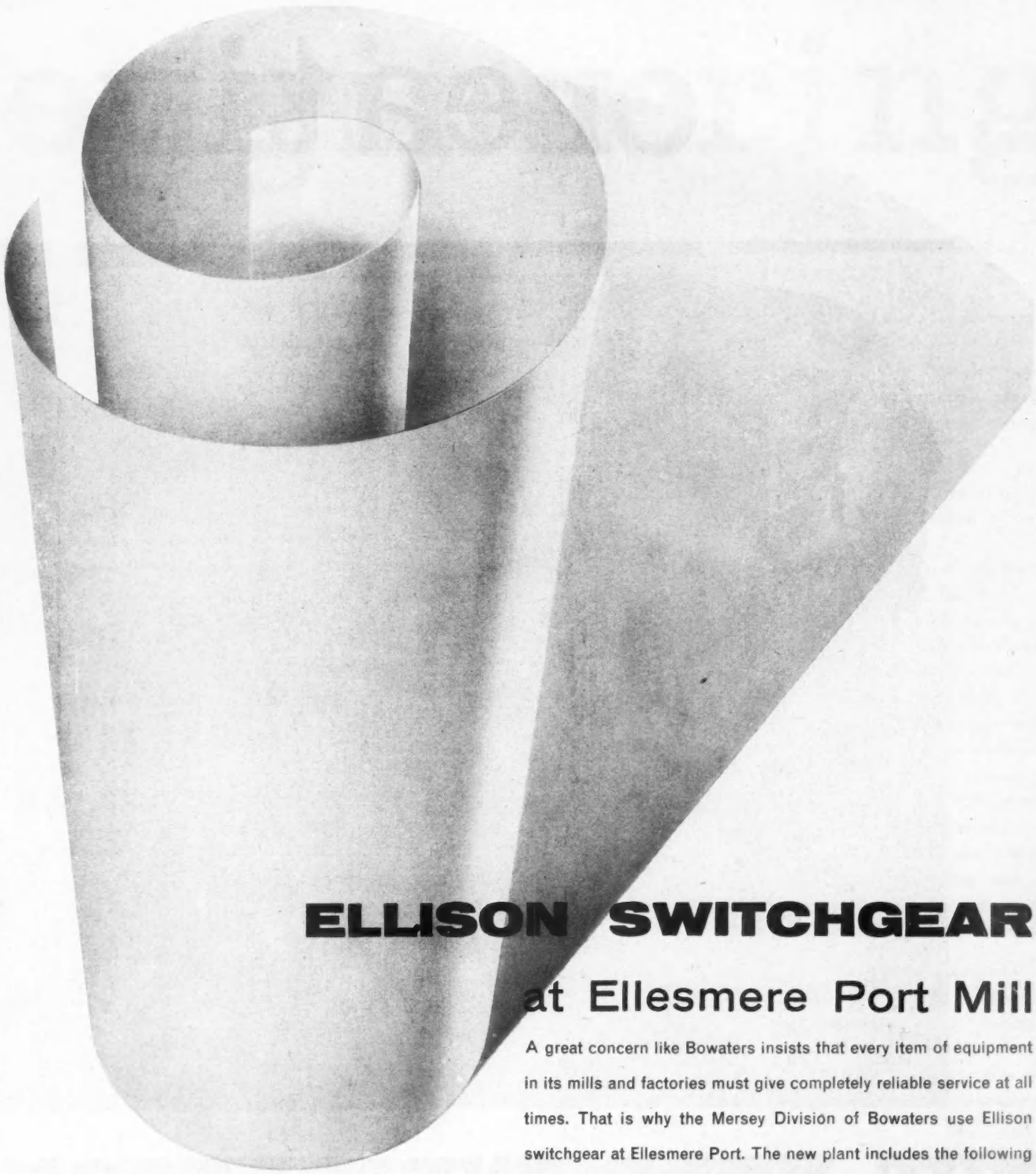

ELLISON SWITCHGEAR

at Ellesmere Port Mill

A great concern like Bowaters insists that every item of equipment in its mills and factories must give completely reliable service at all times. That is why the Mersey Division of Bowaters use Ellison switchgear at Ellesmere Port. The new plant includes the following Ellison gear:—

(1) An 18 panel, 3·3kV Switchboard, solenoid-operated, for the remote control of hydrapulpers and refiners in the baled pulp preparation plant for newsprint machines.

(2) A 5 panel, 3·3kV Switchboard, solenoid-operated, for the remote control of the stock pumps raffinator and various conveyors and auxiliaries in the groundwood mill.

TRADE MARK

GEORGE ELLISON
LIMITED

PERRY BARR, BIRMINGHAM 22B

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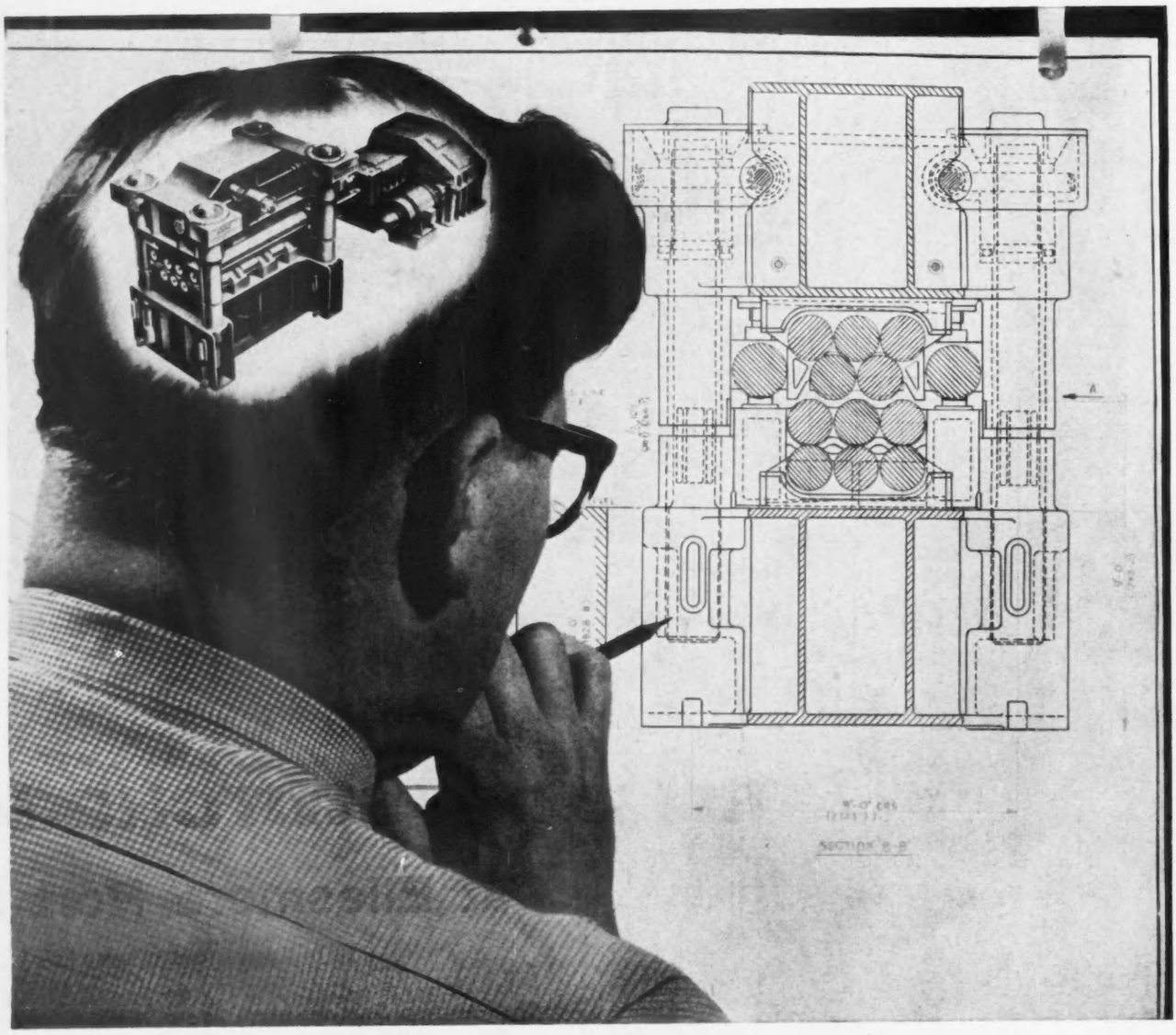
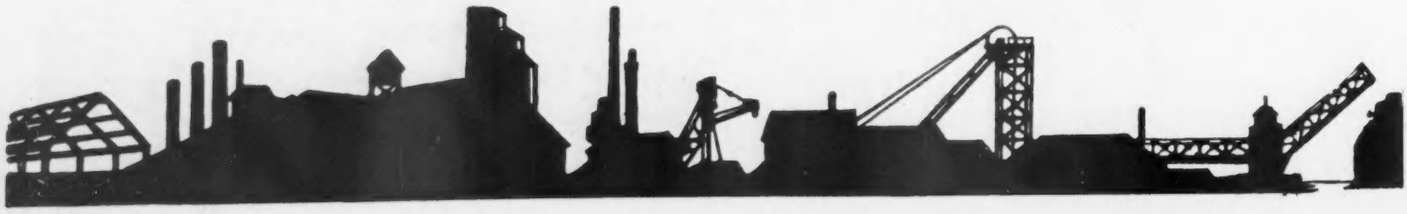
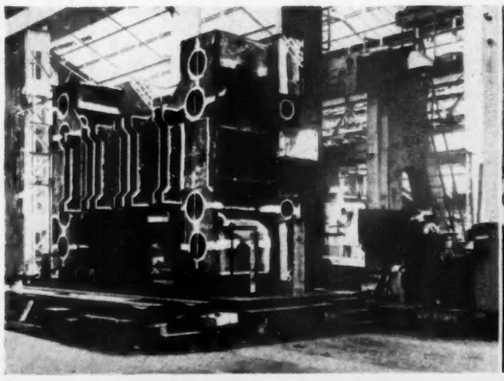


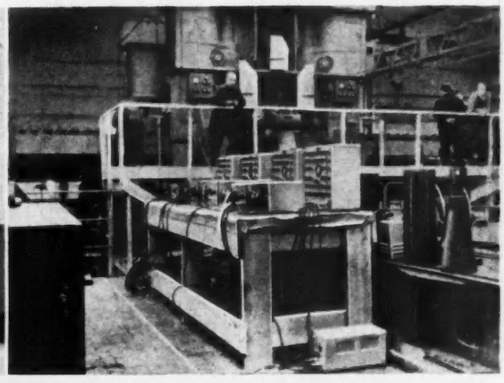
THE HEAD WRIGHTSON

COMMERCIAL STREET MIDDLESBROUGH LONDON



engineering

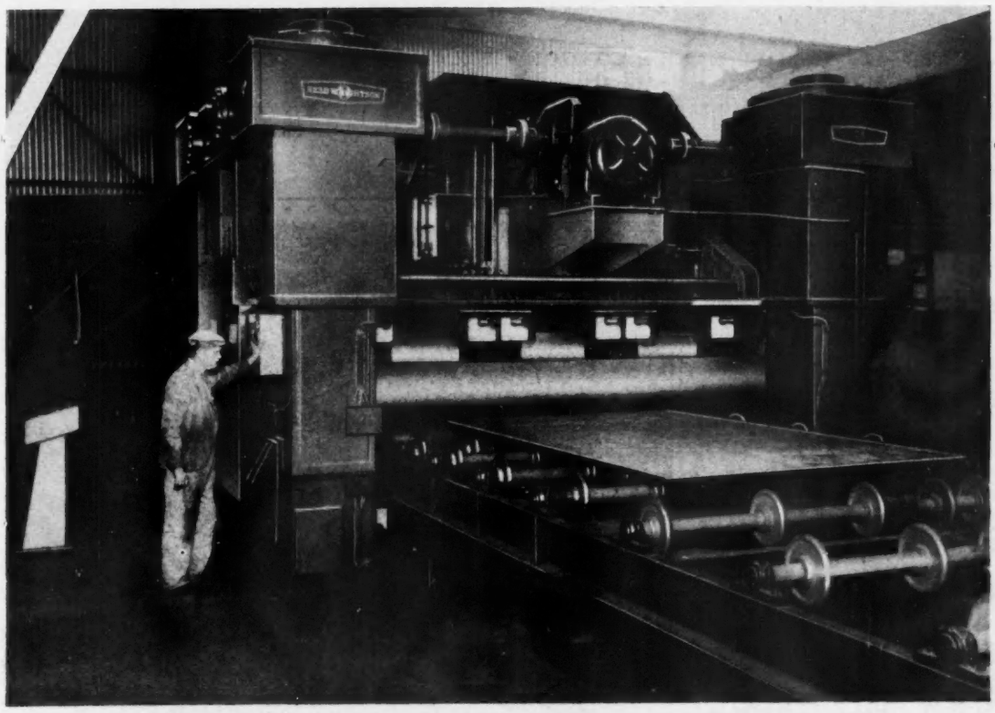




(Left) Leveller beam being machined.

(Right) The leveller undergoing fully instrumented tests prior to installation. Tests carried out with the assistance of the Group Research and Development Section.

(Below) The finished leveller installed and in operation.



Working from basic details, The Head Wrightson Machine Company Ltd. carry through the design and manufacture of capital equipment from enquiry to installation. This ability for creative engineering is well demonstrated by the Heavy Plate Leveller (to handle plates up to 2" thick by 12' 0" wide) recently installed at the Wallsend Shipyard of Messrs. Swan, Hunter & Wigham, Richardson which was designed and constructed by the Head Wrightson Machine Company.

In order to build this leveller it was necessary to prepare an entirely new design in close collaboration with the Research and Development Department of the Head Wrightson Group of Companies.

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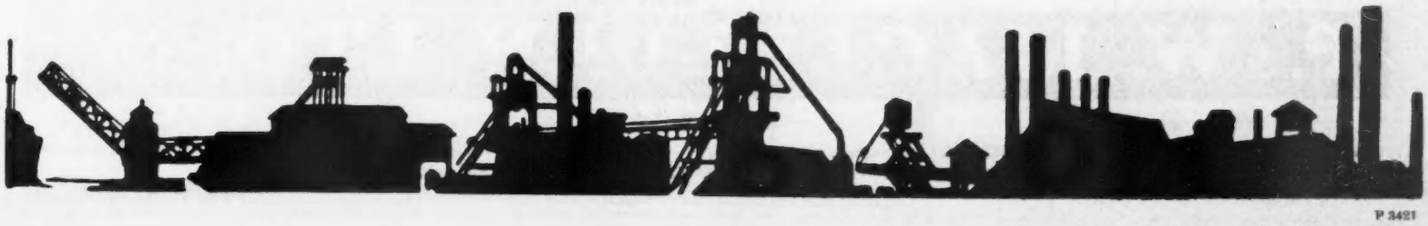

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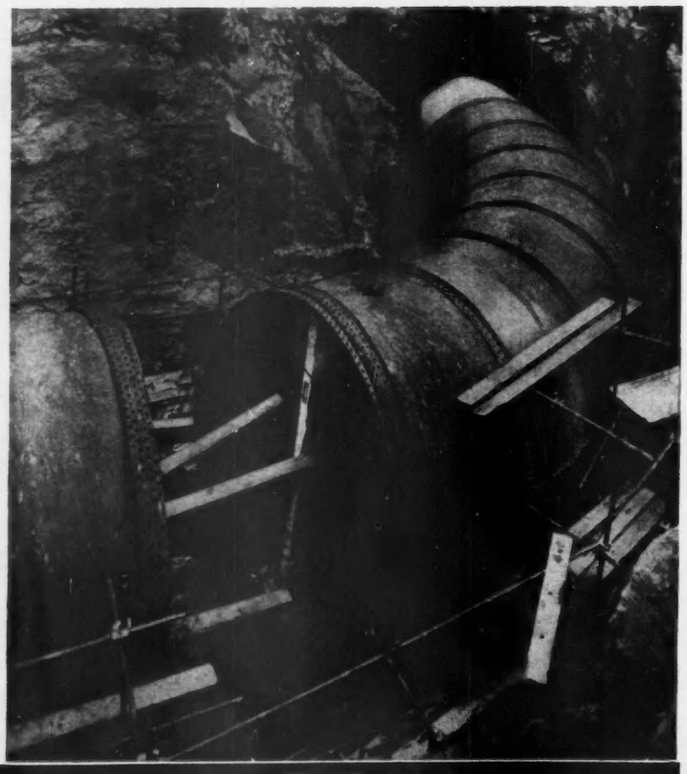

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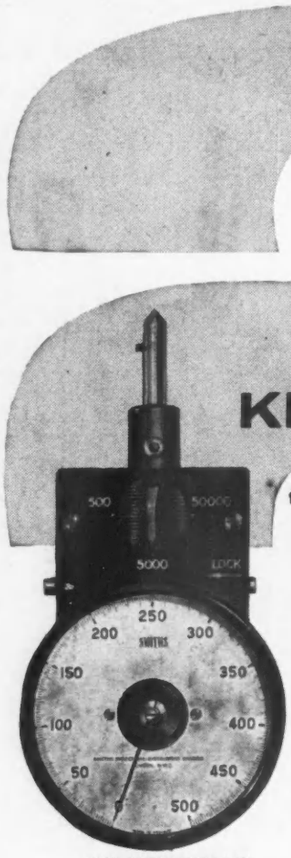

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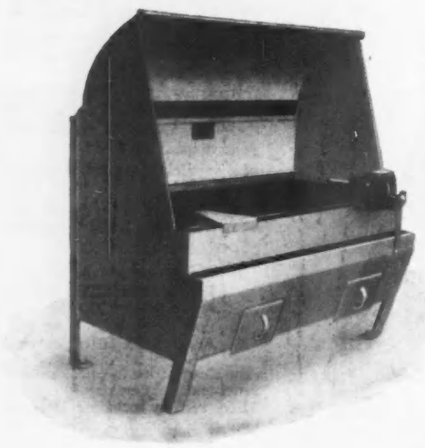

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A new question for every designer of mechanical assemblies

—WET or DRY?

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Every time a designer puts pencil to paper to sketch an assembly of moving parts he works within a constraint which has become so familiar that he scarcely recognises its existence. This constraint is the necessity to provide oil, grease, graphite or pressure lubrication for all sliding surfaces. GLACIER DU Bearings break this constraint. They never need oiling!

DU: A SENSATIONAL BREAK-THROUGH

DU Bearings have been described in America as "a sensational break-through in bearing technology". The reason for this is that although dry bearing materials had been in use before—process industries and extreme-temperature-duty applications, for example—until GLACIER developed DU, no dry bearing material had been discovered which combined such low friction with such high resistance to wear and great mechanical strength. DU Bearings for the first time widen the scope of dry bearings to include almost every application. They were originally developed —and are made exclusively—by GLACIER.

WHAT IS DU?

DU, the material from which GLACIER DU Bearings are made, consists of a tin-plated steel backing on which a thin layer of porous bronze is laid. This is impregnated with a mixture of lead and a fluorocarbon known as FLUON*. DU combines all the advantages of these materials, including resistance to wear, low friction and anti-adhesiveness, high thermal conductivity, low thermal expansion, high mechanical strength, wide service temperature range—from −200° to +327°C.—resistance to abrasive atmospheres, elimination of contamination, and the ability to run submerged even in corrosive liquids—often with improved performance. Its lasting powers are excellent; it can carry heavy loads at high speeds; it requires no attention and of course no oil whatsoever.

DQ SOLID FLUON MIXTURE

GLACIER DQ solid moulded FLUON mixture is available in tubes and rods up to 2" dia. and 7" long. Unlike DU it can be machined all over to make difficult or very small shapes. It is a homogeneous mixture and is therefore less sensitive to edge loading and some types of corrosion than DU.

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For a number of years GLACIER DU and DQ Bearings have been very successfully used in a number of specialised applications. There are nearly 400 of them in each Comet. Other users include such distinguished names as de Havilland, Rolls-Royce, Courtaulds, Jaguar, E.M.I. and Metropolitan Vickers. But through the mechanical field there are more applications for DU and DQ. Dry mechanical assemblies are now a possibility to be borne in mind by every designer. GLACIER DU and DQ Bearings can bring about tremendous savings in design, cost and maintenance.

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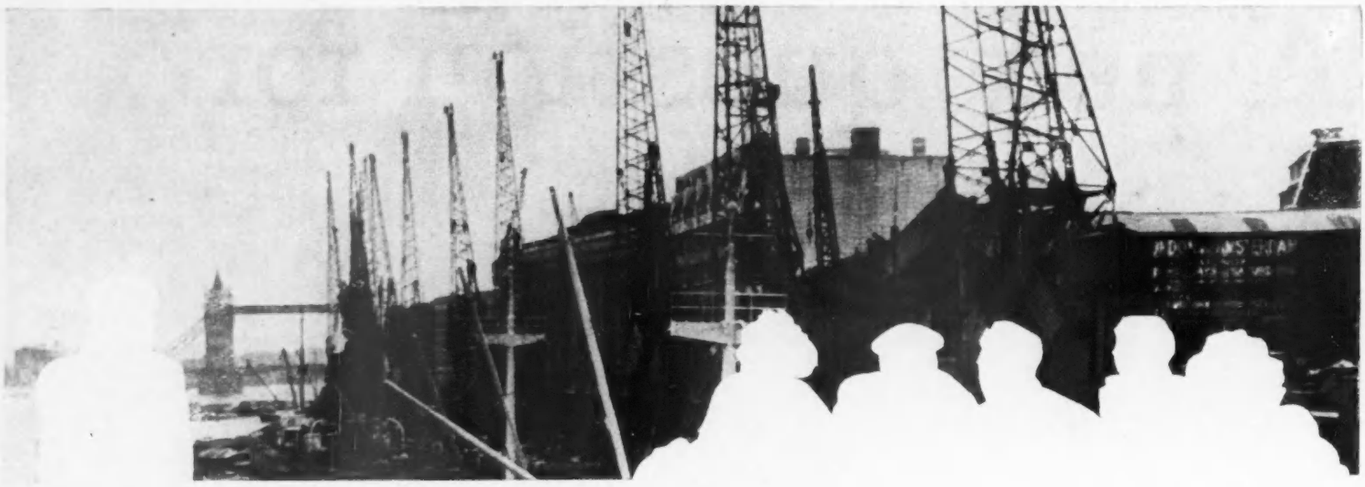

watching the cranes go high

The busy scene at the dockside has always fascinated that large part of the human race which just likes to stand and stare. These cranes loading and unloading at the Port of London and their appreciative audience form a picture which is repeated with variations at docksides all over the world.

Wherever the scene is set observant spectators will notice that the ships with the quickest turn-round are **served by Stothert and Pitt cranes.**

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- *are specially finished — for resistance to rust and corrosion*
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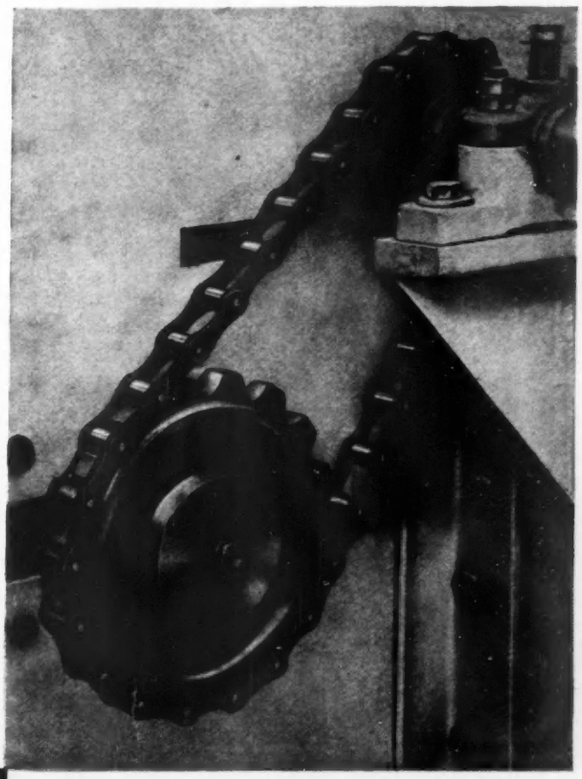

THE COVENTRY MARK 5 steel roller chain replaced malleable chain on this Hydro Washing Machine with marked all round improvement in running

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Coles handled Admiral Byrd's giant Sleighs, constructed for the Geophysical Year exploration; they unloaded Sir Vivian Fuchs' Sno-Cats, after the successful Trans-Antarctic exploration; a Coles Crane helped build 'Atomville' —the atomic village that serves the Monte Bellos Rocket Range in Australia.

For their outstanding combination of strength, mobility and accuracy with exceptional power flexibility, Coles have been chosen to carry out many important and precise operations, such as handling safely the largest piece of glass in the world and the costliest Rubens painting, 'Adoration of the Magi'. Coles Cranes were used in the loading and unloading of the statue of Christopher Columbus, shipped from Genoa to Columbus, Ohio.

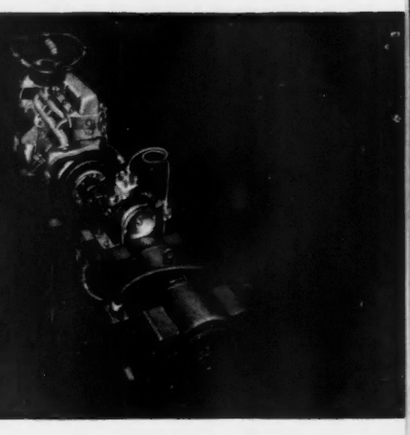
* REGISTERED TRADE MARK

WIDE VISION CAB

Designed for maximum comfort plus efficiency, the operator is situated in a forward position on the full-circle-slewing superstructure—his eye is always on the hook, with large wide vision windows giving an unrestricted view of your working area.

ELECTRIC TRANSMISSION

Efficient and robust Electric Transmission provides a fully controlled smooth flow of power at the touch of a switch, with easy operation and simple maintenance without specialised knowledge. Hoist, slew, derrick and travel motions are independently powered and operated individually or in combination as required, with an infinite range of speeds from zero to maximum.



CRANES *are an investment in design*

ONLY COLES CAN CLAIM :—

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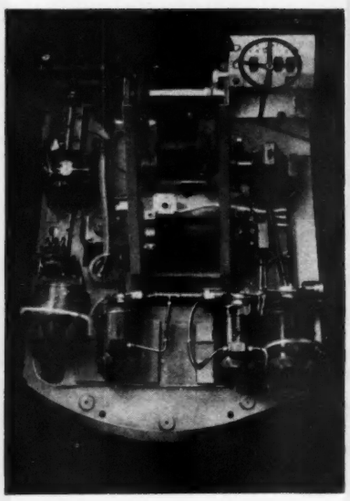
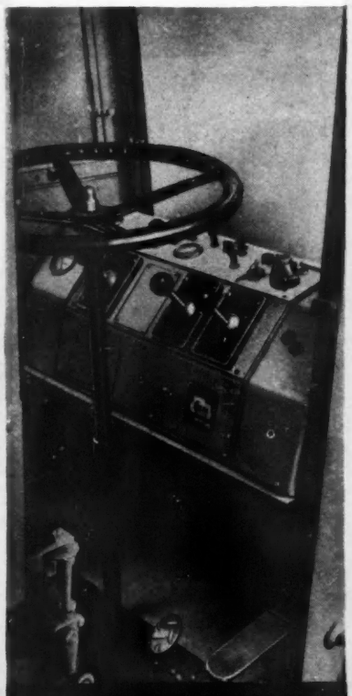
. . . and over 80 years' experience of the biggest, toughest and most complicated handling jobs is behind the design of Coles new range of Diesel-Electric Cranes ; from Concrete to Air Engines, Coles flexibility counts.

When you use Coles you achieve speed and precision with safety.

UNIT CONSTRUCTION

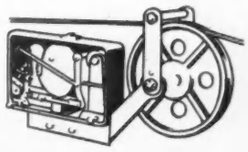
Coles Cranes are designed for maximum work with minimum maintenance ; this clean, simple layout ensures easy maintenance with quickly removable, self-contained, totally-enclosed units. The superstructure base is accurately machined to receive the self-contained units of hoist, derrick and slew motions, power unit and generator. Easily removed panelling gives maximum weather protection and quick accessibility for ease of servicing.

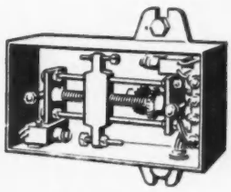


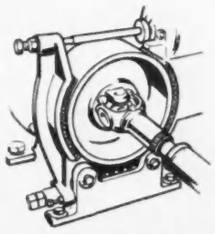


FINGER-TIP CONTROL

After only a few minutes instruction anyone can operate a Coles Crane. Pilot switches and accelerator are grouped together for easy, fatigue-free operation ; every control movement is instinctive, leaving the operator free to concentrate upon signals and his load. Coles finger-tip electric control ensures a fresh, alert operator efficient to the end of the day—a vital safety factor.

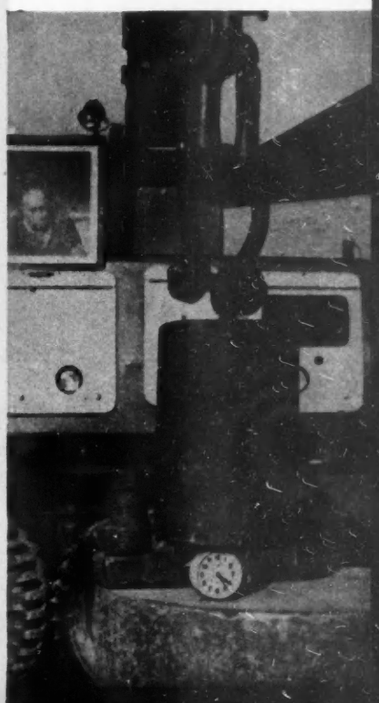






SAFETY

Coles many safety devices remove the human element risk and give the operator the security and confidence which enable him to work efficiently under all circumstances. In addition to the visual radius indicator which shows the safe working load, an automatic safe load indicator is fitted to weigh the load at a given radius, also giving the operator visual and audible warning of any tendency to overload—while preventing automatically the lifting of an unsafe load, irrespective of jib positions.



PRECISION WITH SPEED

Coles fast, finger-tip controlled motions provide an infinite range of speeds from zero to maximum. Faster, smoother, safer operation with maximum handling economy is obtained by simple operation of the accelerator pedal.

Designed, manufactured and marketed by:—

STEELS ENGINEERING PRODUCTS LIMITED,
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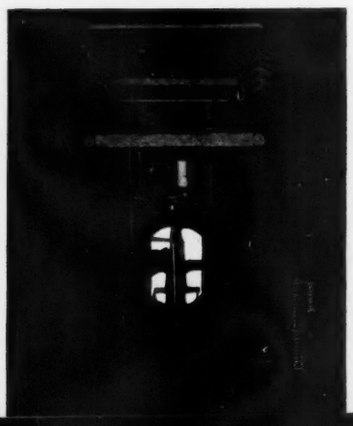
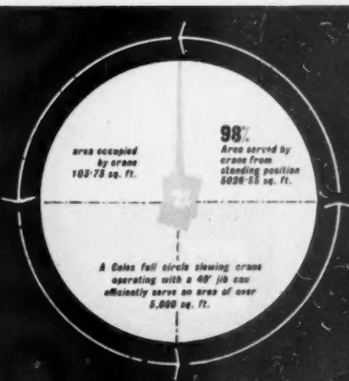


EFFORTLESS TRAVEL

Coles Cranes move fast on the road and are designed for swift, easy movement from job to job, under all operating conditions ; built specially to withstand the heavy stresses and shock loadings unavoidable on Crane duties. Our road travel experience is greater than any other European Manufacturer, let us pass this on to you.

FULL-CIRCLE SLEWING

The operator, situated on the front of the full-circle-slewing superstructure, can place the hook in any position within a circle, having a radius equally the length of the jib ; he can reverse the motion and slew in the opposite direction without limit.


area occupied by crane 103·75 sq. ft.
98%
Area served by crane from standing position 5626·55 sq. ft.
A Coles full circle slewing crane operating with a 40' jib can efficiently serve an area of over 5,000 sq. ft.

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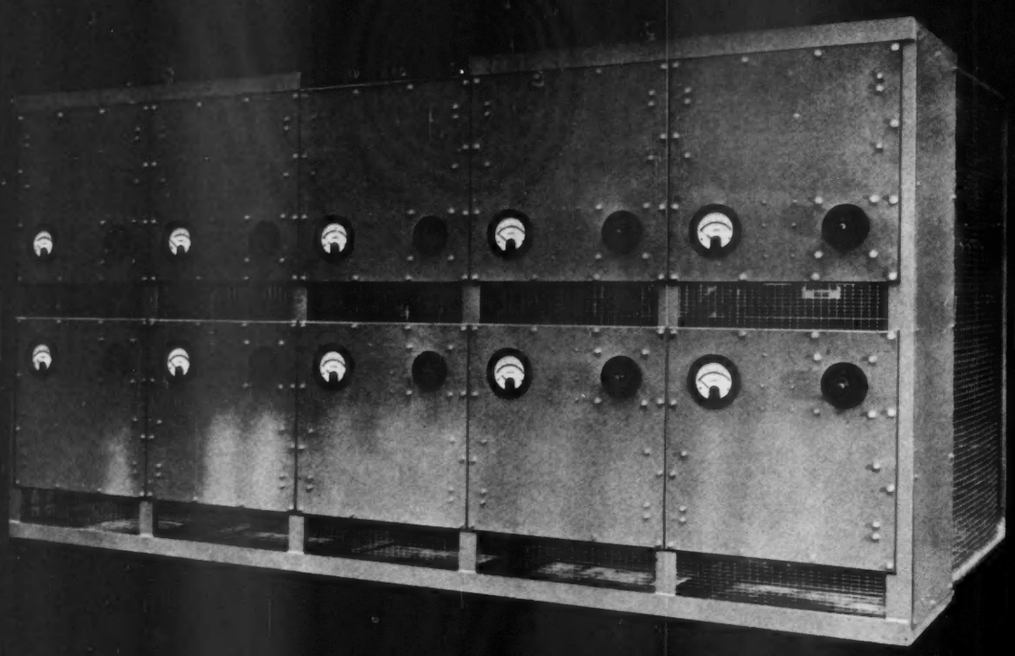
silicon TRANSFORMER RECTIFIER EQUIPMENTS



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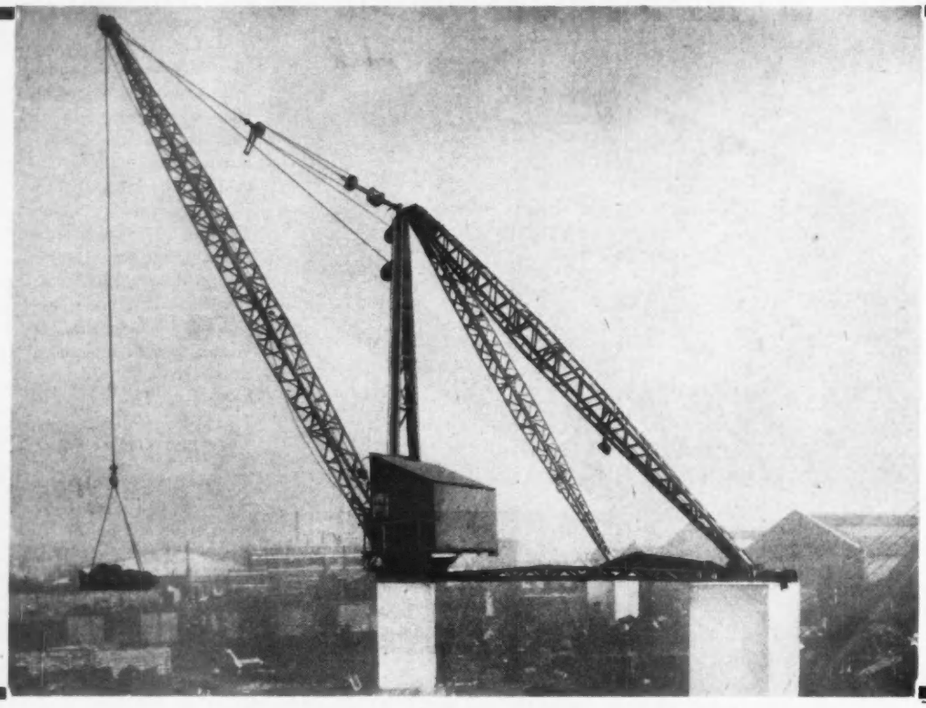

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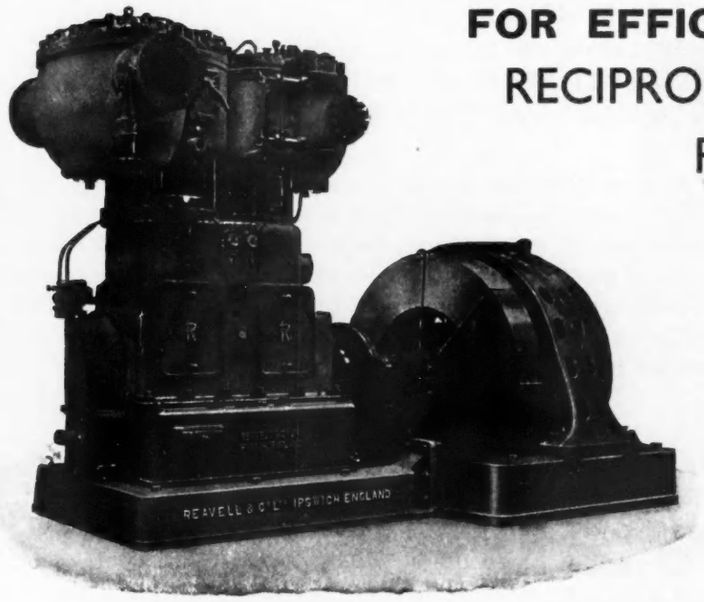

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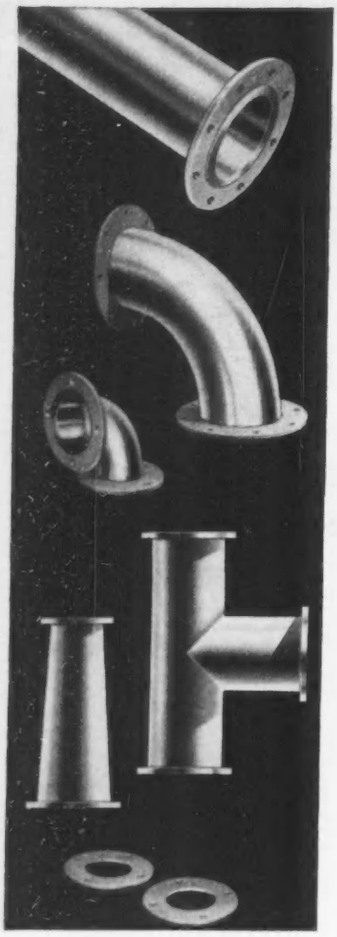

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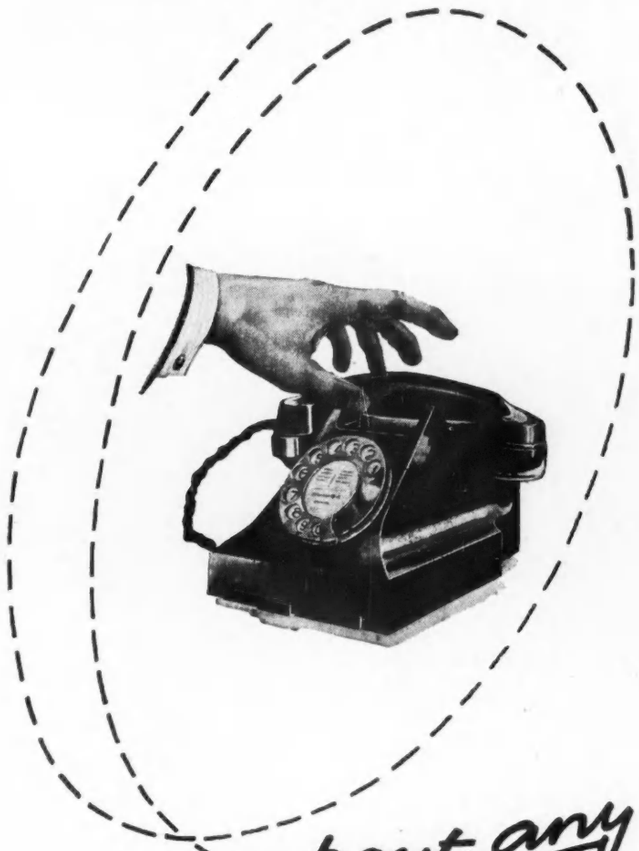

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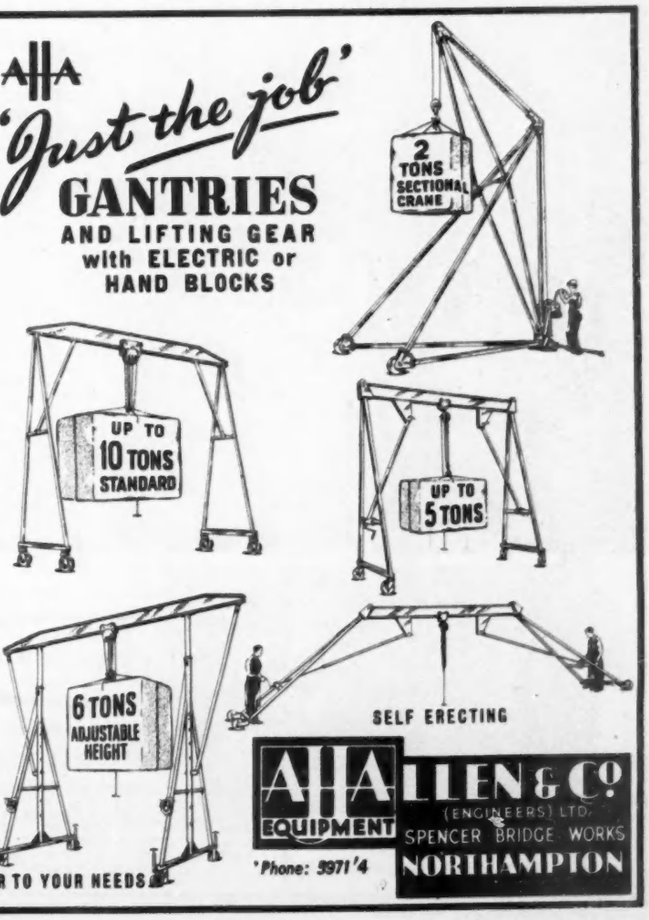

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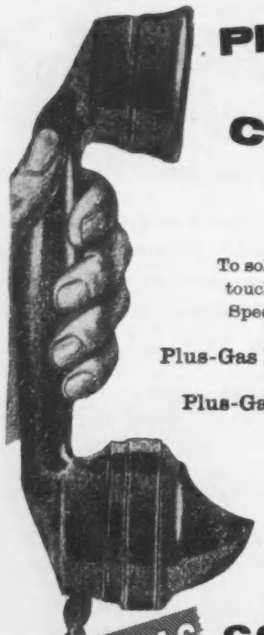

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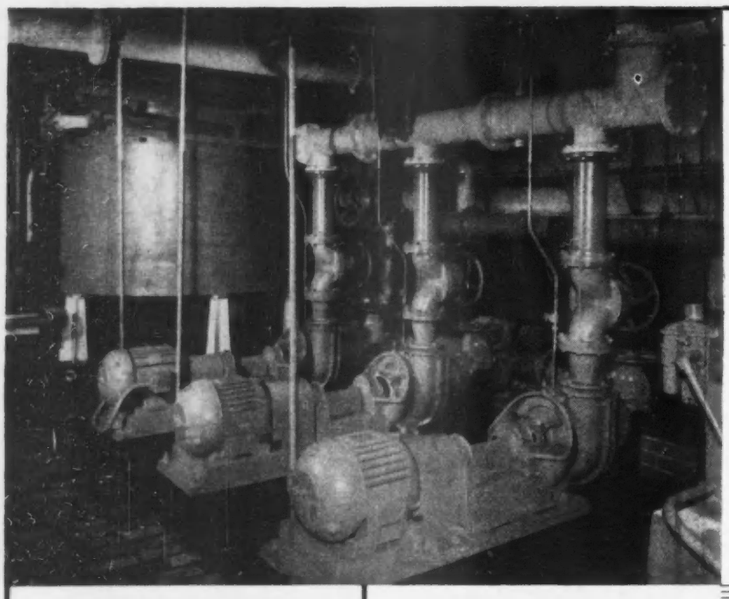

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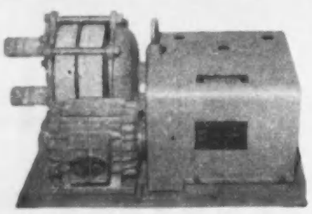
(Bottom left) Close-up view of diaphragm pump similar to the hand operated unit but arranged for motor drive
(Bottom centre) Hand operated portable diaphragm pump for emptying carboys or tanks and for general duties.
(Bottom right) Portable rotary displacement pump pumping plating solutions in the motor car trade



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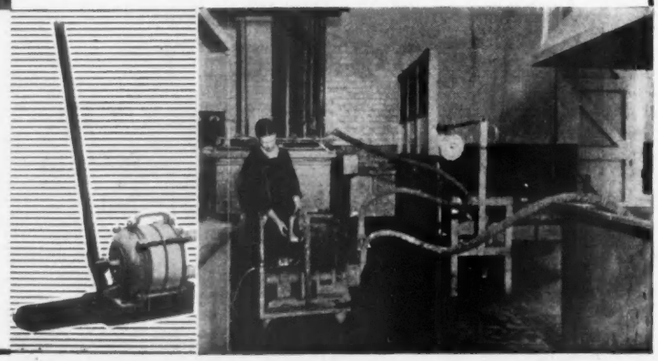

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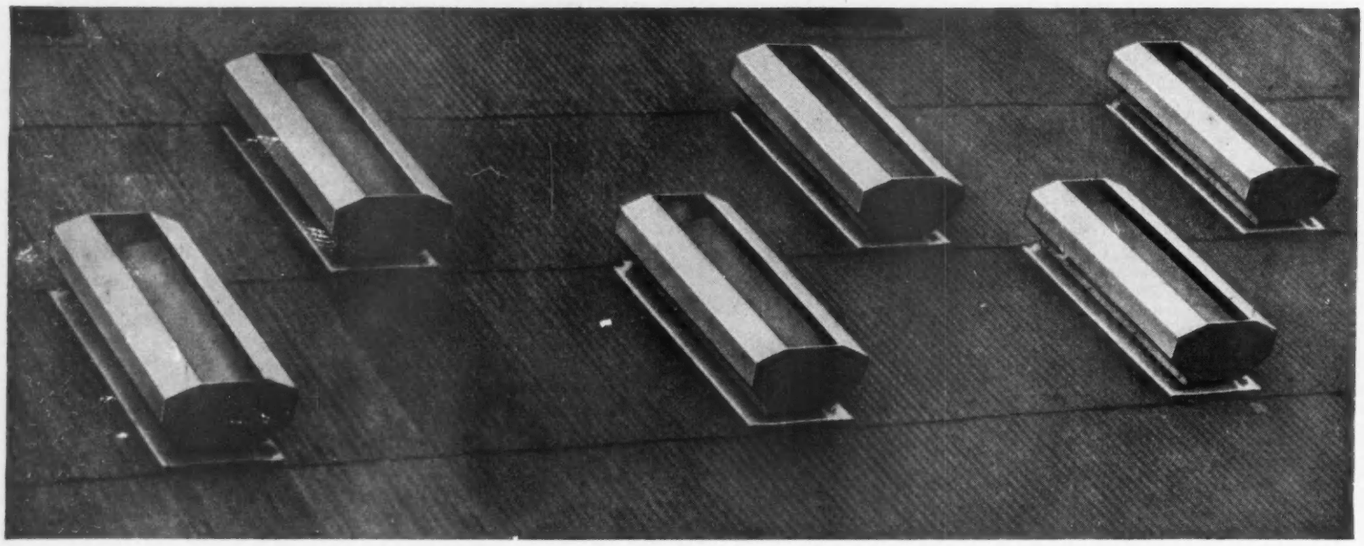
TH COWL EXTRACTOR VENTILATORS



Anti-corrosive aluminium alloy cowling eliminates maintenance.

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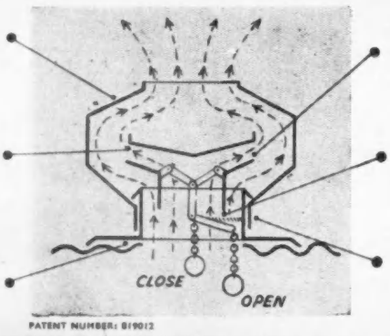

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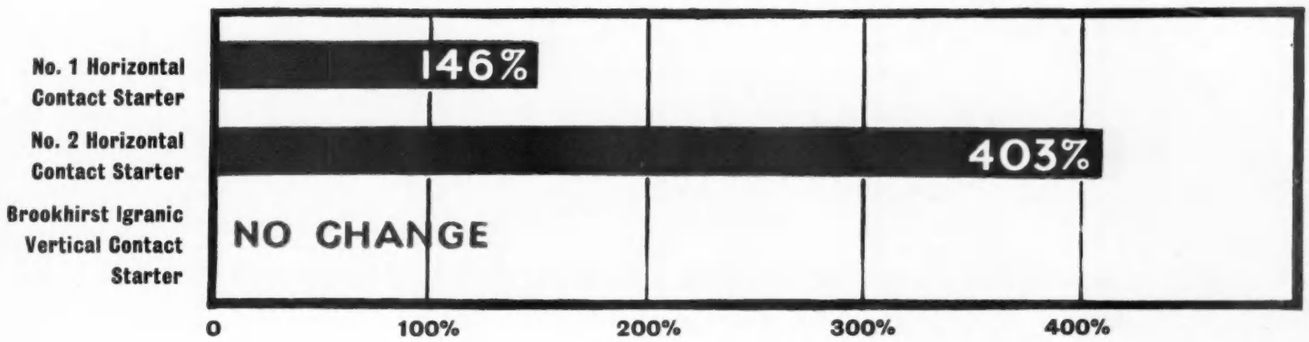

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The Brookhirst Igranic vertical contact starter alone showed no increase in contact resistance due to dust deposits, because dust cannot collect on vertical surfaces. Increased contact resistance through dust leads to heating, pitting, wear and failure.

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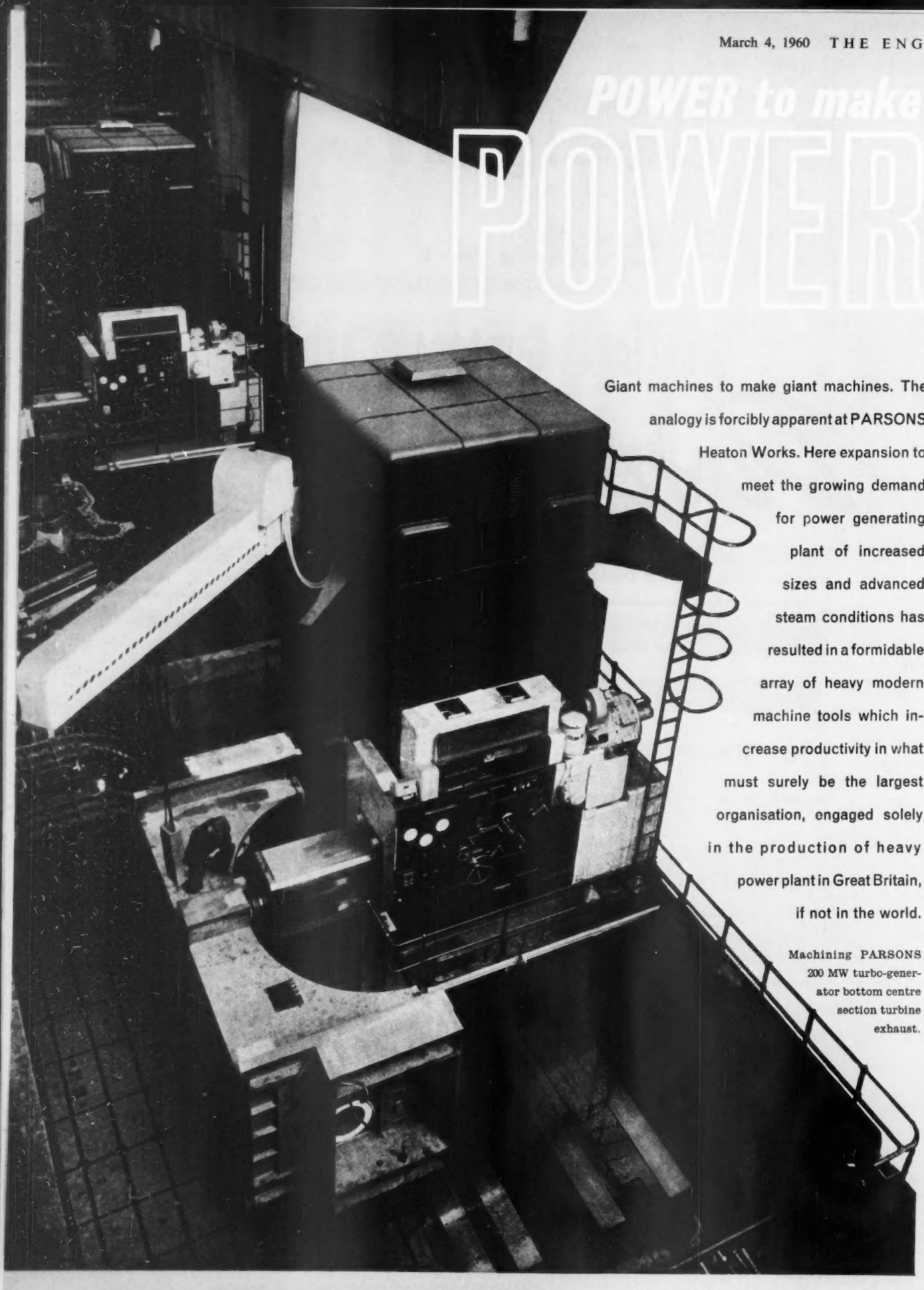

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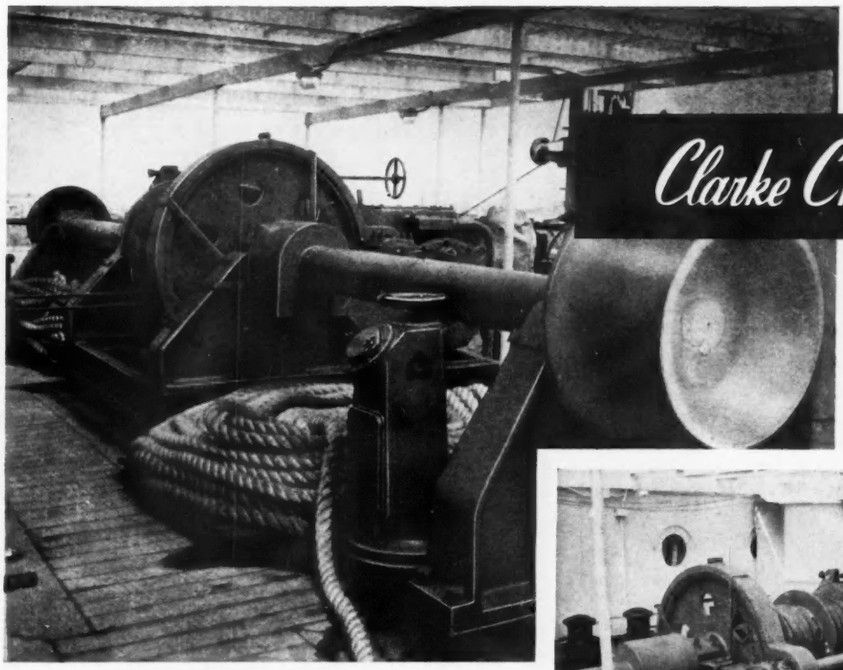

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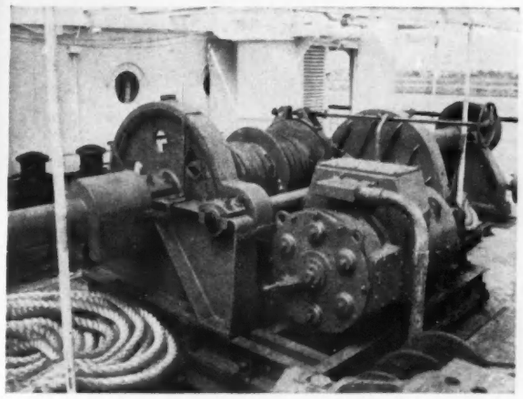

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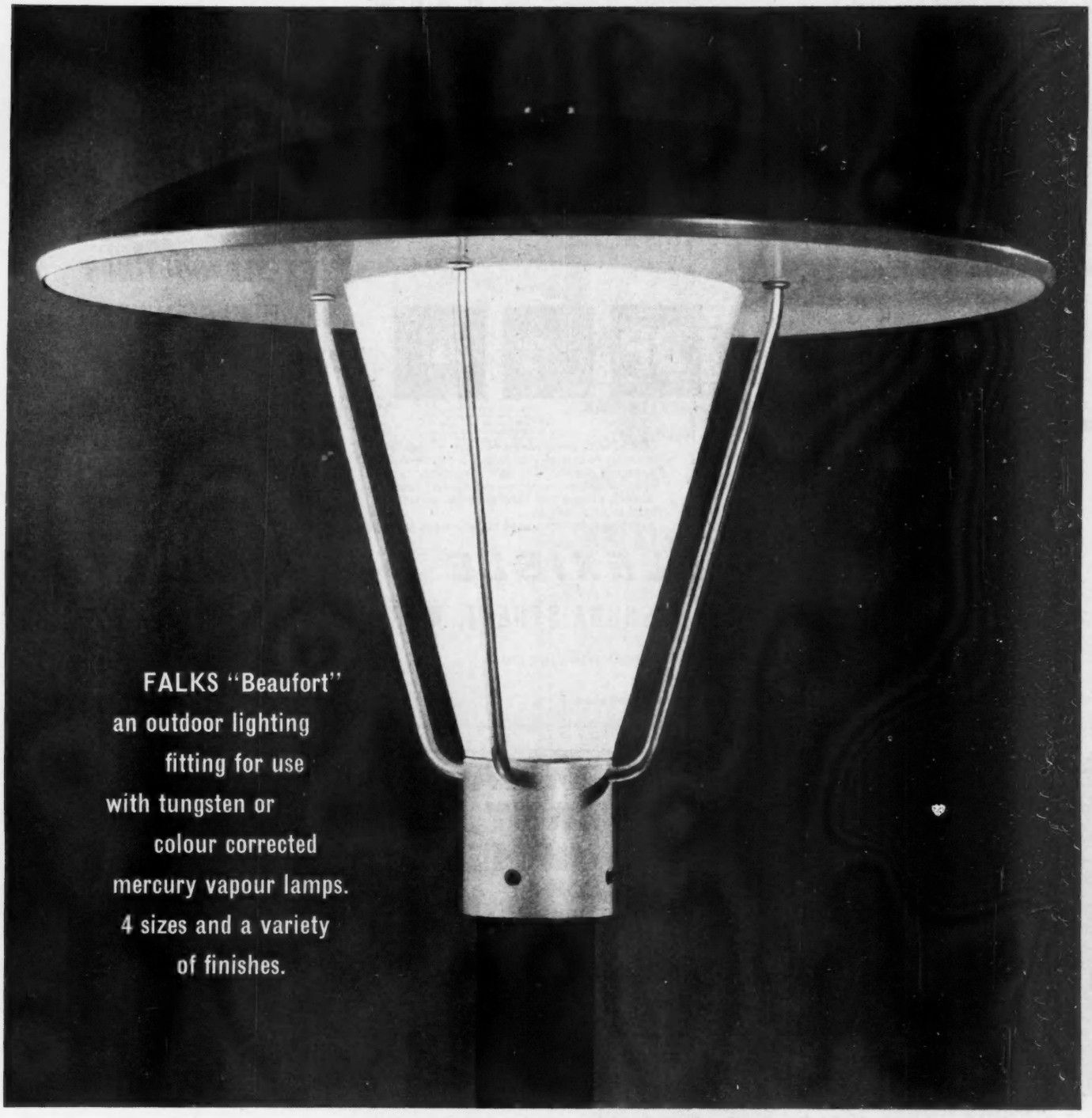

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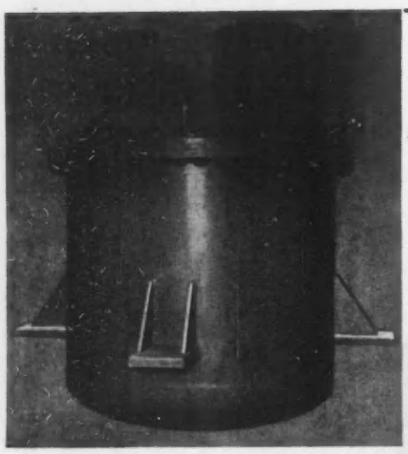

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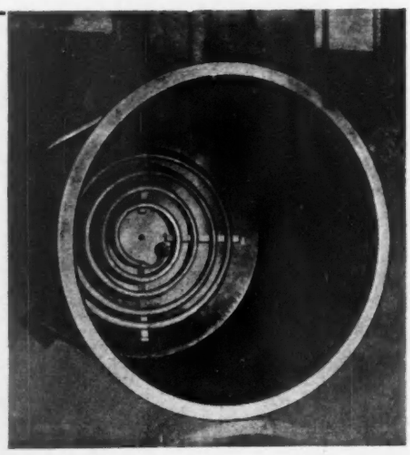

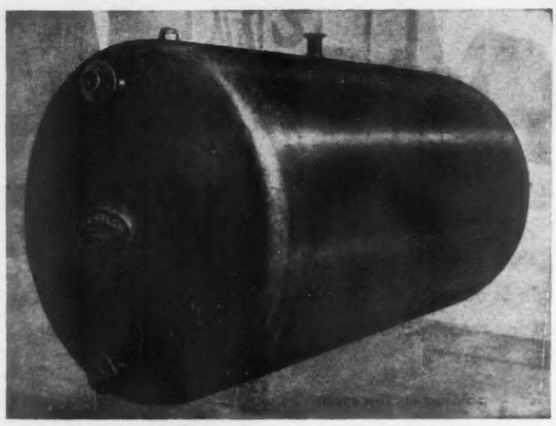

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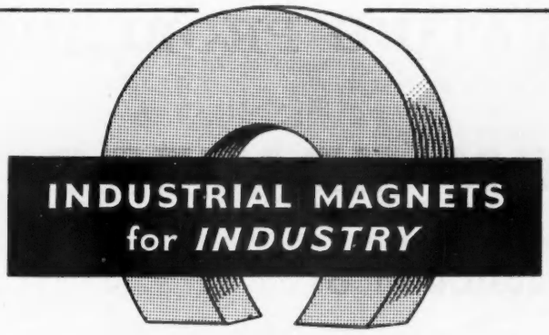

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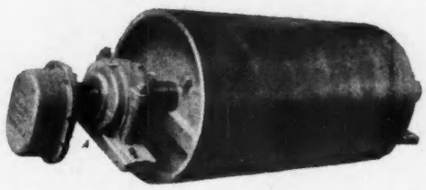

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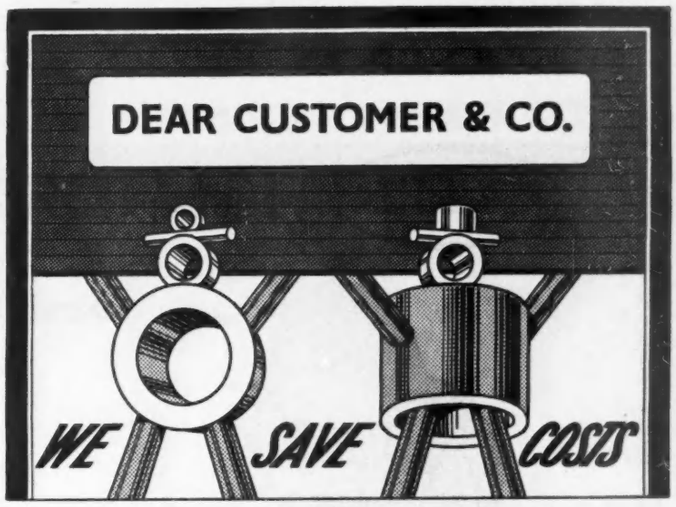

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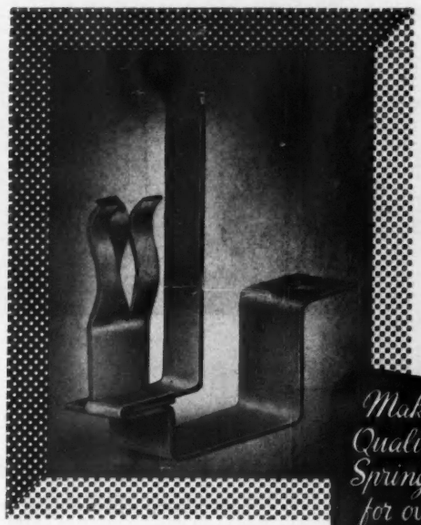

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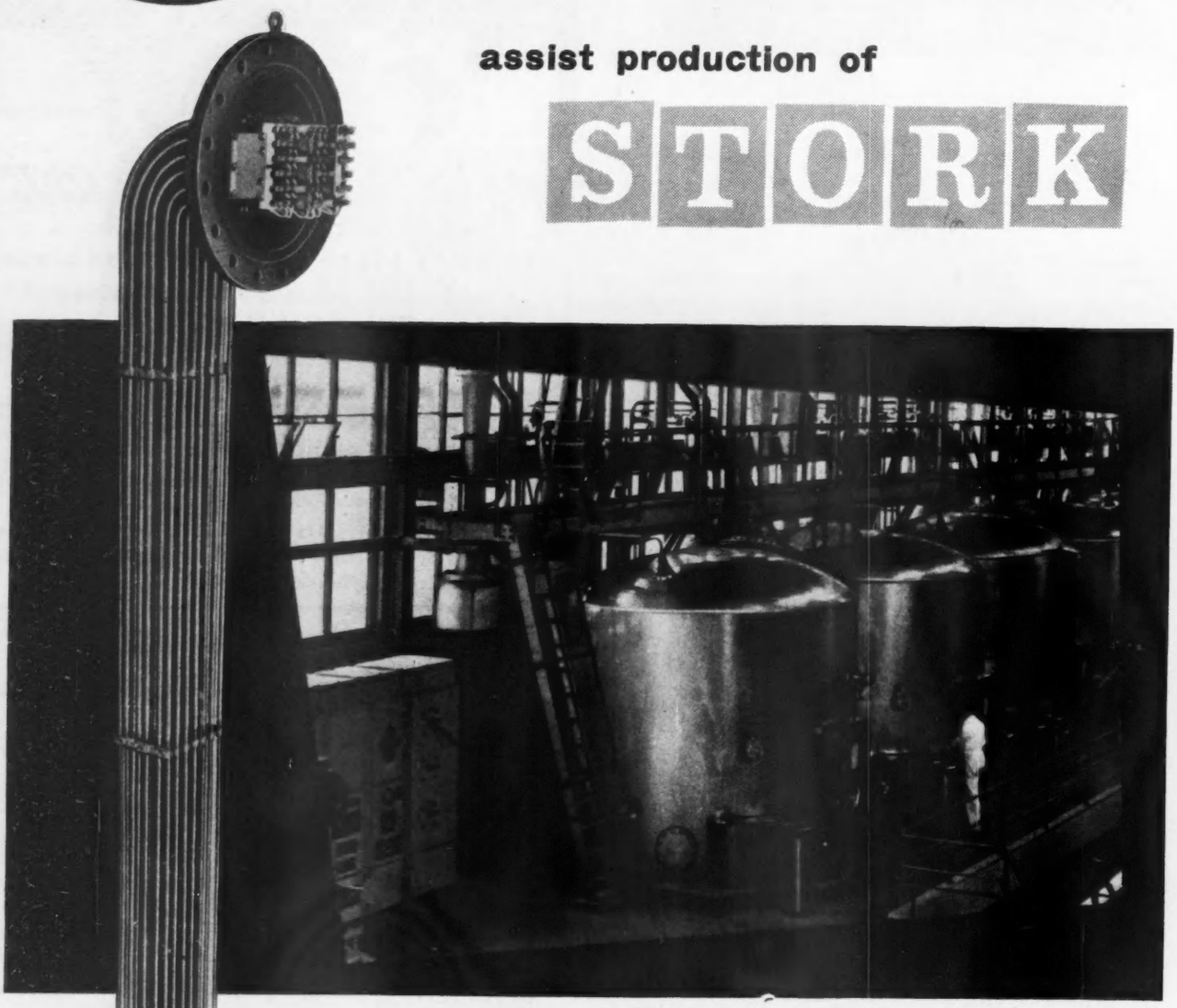

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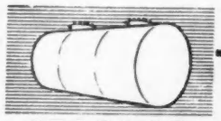

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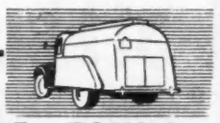

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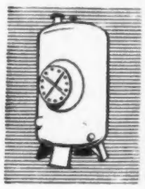

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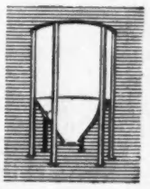

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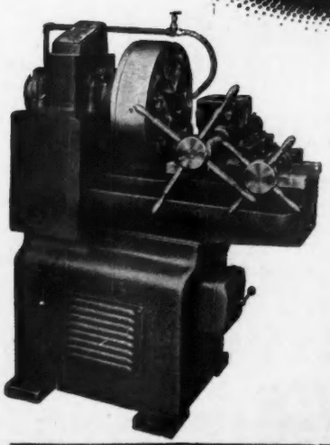

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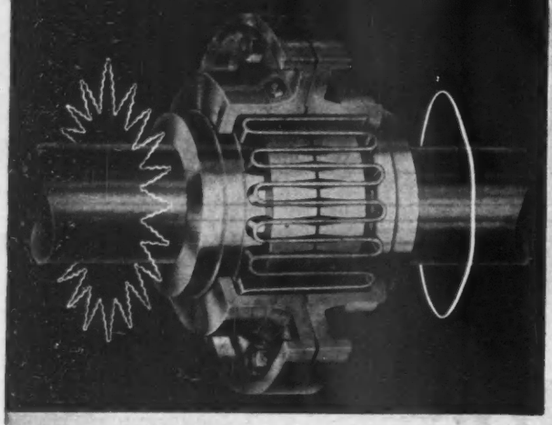

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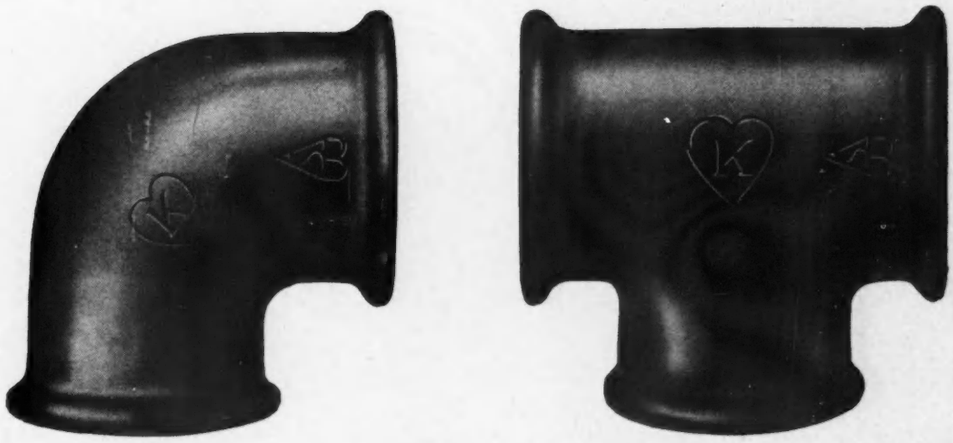

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THE ENGINEER

No. 5432 MARCH 4, 1960 VOL. 209

ESTIMATES FOR THE ARMED FORCES

All three Fighting Services are asking Parliament for a substantial increase in the coming year on the original Estimates for 1959–60. Allowing for receipts, the Navy wants £397½ million (£27,000,000 more); the Army £477½ million (£46,000,000 more); and the Air Force £527½ million (£37,500,000 more)—increases mainly due to the higher pay costs and the higher prices of weapons, materials and supplies. Unlike the Defence White Paper which intimated possible changes in the means used for the long-range delivery of nuclear warheads, the Estimates are, in the main, reports of progress on recruiting and on the re-equipment of the Services with modern weapons and equipment. A second nuclear-powered hunter-killer submarine is to be ordered this year which will be "all British made," though based on American design. Otherwise, apart from the ships already mentioned in this journal and in reference books as under construction, the Navy Estimates provide for the building of five more general purpose frigates—making forty-seven new frigates in all; two minesweepers, a fast patrol boat and an indeterminate number of diesel-electric drive submarines (submarines not yet launched are omitted from the programme). When discussing the Estimates recently at the Admiralty, the First Lord emphasised the high underwater speed and silent running submerged propulsion of these conventionally powered submarines which make them so useful for patrolling in enemy waters. He also confirmed the Civil Lord's statement in Parliament that the conversion of a second operational vessel as a commando carrier is under consideration.

The "Dreadnought" and one of the four new guided missile ships are to be launched this year and the "Lion"—the second ship of the "Tiger" class—is to commission in the summer. It seems regrettable, however, that the Strength of the Fleet Table has to be boosted up by the inclusion of three cruisers on the disposal list and two old carriers in reserve. There are only five—not eight—wartime cruisers remaining and the carrier "Magnificent" would be better fitted out as an exhibition ship for British goods. The conversion of the other old reserve carrier—the "Triumph"—as a repair ship, is almost complete. Afloat support is to be strengthened by the chartering of seven modern motor tankers of 18,000 tons deadweight capacity to replace eleven of the existing old 12,000-ton Admiralty oil freighters; and by modernising several of our repair and maintenance ships. It is also very satisfactory that the senior naval officer in each area is again to be responsible for the operational control of all shore-based maritime air forces. The "Wessex" gas turbine anti-submarine strike helicopter will start replacing "Whirlwinds" during this year and the small ships' killing range will be increased as the result of successful trials of operating from frigates a small helicopter carrying an anti-submarine weapon.

Discussing the Air Estimates, Mr. George Ward emphasised the need for the new ballistic missile early warning station in the hope of enabling V-bombers to be airborne before the arrival of rockets. The station—to be built in Yorkshire at a cost of £43,000,000 (largely provided by America)—will take two or three years to construct. He also stresses in his explanatory memorandum the increased strategic mobility of the Army through developments in Transport Command. During the year it will be equipped with "Britannias" and "Comets," with the addition of the "Britannic" freighter in the early future. The "Victor 2" bomber—delayed by loss of the prototype in August—should enter service next year and during the next few months the last "Victor 1" squadron will be formed and all the "Thor" rocket sites will be fully operational. Both the "Lightning" fighters—the first squadron to be formed in 1960—and some of the "Javelins" are to be fitted for in-flight refuelling. The Army Estimates also give evidence of a marked increase in the Army's mobility and striking power. Prototypes of the new battle tank, the tracked armoured personnel carrier and the "Centurion" bridge-laying tank, will undergo trials this year and a sufficient number of the Italian air-portable 105mm howitzers are to be purchased to re-equip the parachute light regiment and three other field artillery regiments in the coming months. The Australian anti-tank guided missile "Malkara," now on order, will be mounted on vehicles, as distinct from tanks. The "Wombat"—a lighter version of the 120mm anti-tank weapon—and the F.N. general purpose machine gun, replacing both the Vickers machine gun and the Bren, are shortly to undergo trials and by the end of the year the Army will have been re-equipped with the "Saldin" armoured car, the "Ferret" scout car and the armoured 1-ton wheeled vehicle. A second R.A. regiment is being armed with the "Thunderbird" surface-to-air guided missile.

EXPONENTIAL EXPANSION

The other day we made reference in a leading article to the apparently exponential rate of progress in aircraft design. No doubt our use of the word exponential, which has, of course, a very definite mathematical meaning, in relation to the somewhat vague concept of rate of advance in aircraft design was taken by readers to be a figure of speech. But in other fields the word can be used with full mathematical rigour to describe the way certain measurable factors in our modern civilisation are expanding. For example, if the powers sent out per annum from C.E.G.B. electric power stations in this country are plotted against the years an exponential relationship will be found to exist between them. Again, as Mr. Schumacher of the National Coal Board has repeatedly pointed out, the demand for fossil fuels has been increasing over the last hundred years or so at almost 3¼ per cent per annum compound with the consequence that in each quarter century as much fossil fuel is used up as within the whole of history before! The speed of aircraft has increased exponentially, too. Moreover, on somewhat less sure ground, any man old enough to look back to the early years of this century may well

ask whether there is not evidence of something exponential in the very increase of man's knowledge about his environment and in his means of applying that knowledge. In the year 1900 no powered aeroplane had flown, motor transport had only just begun to appear on the roads, there was no broadcasting or television, the cinema was a novelty, there were no antibiotics, few artificial fertilisers, no radar and no nuclear power. Even electricity had only just begun to make a mark upon production methods in factories and upon domestic drudgery in the home. Probably the last fifty years have seen a greater change wrought in the living conditions of Western man than has occurred in any previous so short a period.

But is it therefore safe to predict that the same tendency towards an exponential expansion of man's scientific knowledge and material use of it will persist far into the future ? We very much doubt it. For is there not already evidence that a law of diminishing returns applies ? It is surely significant that high rates of advance are to be observed primarily in more recently discovered fields for human endeavour, as in the application of electronics, of aerodynamics, and of nuclear reactions. Much lower rates of advance are to be seen in older technologies. Despite electrification, railway train speeds are not very much higher, even in France, than they were fifty years ago ; and on the roads the touring speeds of motor-cars, to judge from our own experiences, are increasing arithmetically against the years at about a mile per hour per year rather than exponentially. Other products, such, for example, as large marine oil engines appear, like the marine steam engines they began to replace some forty years ago, to be approaching a degree of refinement which allows not very much room for further improvement, so that the quite substantial research and development exerted in that field yield a relatively small return. It is characteristic of many of the products of engineers that they tend to develop into devices upon which it is more and more difficult to improve except at greater and greater relative expense. The way out, of course, is to break through into entirely new fields and to find thereby devices of a different nature to replace those so far gone in that process of refinement, which we call development, that further progress becomes slow. In that way, for example, the coming of the small internal combustion engine encouraged a vaster expansion of road transport than the steam engine could have supported, and made powered flight by heavier-than-air machines possible. Similarly the replacement of the steam engine by the steam turbine made it possible to generate electric power really cheaply and in very large amounts with revolutionary consequences for man's living standards. The Hovercraft may produce a similar " break-through " in say, cross-channel, and possibly even ocean, transport. The coming of nuclear power promises to relieve the world of the fear—reasonable enough when the demands upon fossil fuels are increasing exponentially—that within a century or so supplies of such fuels will begin to run out so that power will have to be rationed.

But—maybe we are wrong—it seems to us to be growing more and more difficult and costly to make such new discoveries ! Greater and greater amounts not merely of money but of human effort have to be concentrated upon the finding and developing of each successive new discovery. There must surely be a limit to the effort that mankind will think it worth while exerting. Earlier pioneers like, for example, Faraday, making discoveries which contained the seeds of immense subsequent developments used simple and cheap equipment. By contrast, large teams of scientists and engineers are working and many millions of pounds are being expended upon modern researches into nuclear power and interplanetary space and a great many other matters besides. Since there is presumably a limit to the number of people intellectually fitted to lead the advance and since there are values other than the material which many of those with good brains may prefer to seek, it can be anticipated that at some time, possibly quite soon, the rate of advance will become less. In the history of man there is some evidence that outbursts of energy which led to improved understanding of the nature of things and to altered ways of living have been interspersed within long periods of stagnation when very few changes occurred. It seems to us by no means unlikely that some such stability in the affairs of men might re-establish itself within the next century particularly should exploration of the Solar System prove fruitless of advantages to man. But for our part, as engineers, we are thankful to have lived and had our being in an age so stirring as our own.

TERCENTENARY OF THE ROYAL SOCIETY

It falls this year for the Royal Society to be congratulated upon attaining its Tercentenary. The celebrations will be held from Monday, July 18 to Tuesday, July 26. It is curious to reflect that the foundation of the Royal Society was rooted in the meetings of certain men, interested in learning from experiment, who lived at a time associated in most people's minds, not with science, but with the political ferment of the struggle for power between King and Parliament. Thus, at one and the same time, the ideas that all scientific wisdom were enshrined in the writings of Aristotle, still current in the seventeenth century, and that Kings had a divine right to rule were both being challenged. Quite possibly there was a connection, for if authority is challenged in one field there must be a natural tendency to question its validity in another. At any rate in the 'forties of the seventeenth century a number of men whom we would now call scientists began to meet together, first in London, and then in Oxford, to discuss matters of interest to them. Separate groups which formed in those two cities came together in 1659 with other men of like mind and began to meet more or less regularly at Gresham College in the City of London ; and upon the restoration of Charles II to the Throne in 1660 they decided to set up a " Society for promoting Physico-Mathematical Experimental Learning." In 1662 King Charles granted it a royal charter of incorporation as Regalis Societas, the Royal Society. Through many vicissitudes of fortune that society has survived to become the peculiarly highly respected body which exists to-day.

At various times in the present century the Royal Society has been criticised for taking too little interest in the applications of science. We are therefore glad to see that the works of engineers are by no means being neglected at the time of the celebrations. Of ten Tercentenary Lectures to be delivered two will be presented by engineers, Sir Christopher Hinton and Sir Arnold Hall, and one, by Professor Lovell, is likely to be of considerable interest to engineers ; and of the many firms and establishments to be visited a substantial proportion will be concerned with the application of scientific discoveries. There will be a Reception by Her Majesty's Government on Monday, July 18 ; a formal opening ceremony at the Royal Albert Hall on the following day ; a Reception by the University of London on the Wednesday ; Receptions by the City of London on the Friday ; a Conversazione at Burlington House on Saturday, July 23 ; and a Banquet at Grosvenor House

on the evening of Tuesday, July 26, to bring the celebrations to a conclusion. On the morning of Friday, July 22, there will be a University of London Honorary Degree Ceremony at which degrees will be conferred by the Chancellor of the University, Her Majesty Queen Elizabeth the Queen Mother. It is hoped there will be other Royal occasions, though it is not yet possible to make any announcements.

" PEOPLE AND THINGS "

Last week we listened with interest and pleasure to an after-luncheon address by Sir Walter Benton Jones, who is chairman of the United Steel Companies, Ltd. Sir Walter was speaking to members of the Institute of Public Relations and their guests and the emphasis was on his conviction that " men are more important than things." A stranger visiting a large industrial establishment, Sir Walter claimed, might be so impressed by the substance of " things " he saw around him and the energy they exuded that such a motto might sound surprising. But Sir Walter went on to point out that, in any unit of industry, the men engaged form a community in which they spend their working days. Their lives cannot be divided into two parts, the one " dreary work " and the other " eat, drink and be merry." Men are just as concerned to be happy in their working hours as in any other hours of the day and if they are to do their work well, as the majority wish to do, they must be well physically and mentally and they must be happy. This, of course, is not a new theme and, we hasten to add, Sir Walter Benton Jones did not suggest that it was. There are frequent expositions of the theories about happiness at work and many examples readily spring to mind of the efforts put forth to make work as pleasant as possible. But there remains a school of thought which deplores the monotony induced by the operation of the plant and machinery which industry now employs in ever increasing quantities. Progressive mechanisation, the prophet of gloom will declare, may lighten a man's labour but in so doing it will turn him into a mere automaton !

Such a melancholy state can be avoided. A liberal outlook on education and training can achieve a great deal. Sir Walter summed it up very neatly by saying that " every man and boy should be taught every job they undertake. In their work they should be kept familiar with their surroundings, they should be given enough information about their community to awaken and to maintain an interest in it. Means should be provided to help and guide those who want to learn all there is to be known about the special products which they make or the processes in which they are engaged. Furthermore, all should be given the opportunity to acquire general knowledge, for however much men may be able to learn while working in a community, that knowledge will be special, and, after all, there are other things worth learning and other things worth teaching." In a machine age which continues to bring so many benefits to mankind, there are undoubtedly " other things worth learning." It is good, for example, to learn that there is still a great deal of scope for creative talent and individual resourcefulness. It is equally good to keep in mind Sir Walter's dictum that " men are more important than things."

THE F.B.I., THE T.U.C., AND THE CHANCELLOR

As is usual at about this time of year, the Federation of British Industries and the Trades Union Congress have both now made representations to the Chancellor of the Exchequer about the coming Budget. Interestingly, there is a wide measure of agreement between the two documents in which they express their respective views. Both point out how much the economic situation has improved in the past twelve months ; and though the T.U.C. emphasises the existence of areas of unemployment and the F.B.I. stresses that there is still available to come into action a substantial amount of spare capacity, those are clearly facets of the same condition. Neither body thinks the time ripe for a further stimulation of the economy ; nor does either think that restrictive policies would be appropriate. Indeed, the T.U.C. document criticises the recent increase in Bank Rate. Both bodies regard it as essential that there should be a rapid growth in industrial productivity. But on that ground there is a certain divergence of view. The Federation stresses the desirability of replacing initial allowances entirely by investment allowances and draws attention to certain desirable changes affecting depreciation and wear and tear allowances. By contrast, the T.U.C., clearly believing " the man in Whitehall knows best " (or at least better than the traditionally wicked industrialist), wants the Government to exercise more control over the distribution of industrial investment and in particular to see that more industry is taken into regions suffering from unemployment. It even goes so far as to suggest that the Government should be prepared to operate factories in such areas itself ! When it comes to the actual proposal of Budget changes the Federation recommends a reduction of income tax and that a beginning should be made with a reduction of surtax. But the Congress, believing that a substantial rise in wage rates is due, and stressing the need to finance the expansion of education, to increased pensions, and to provide resources for assisting underdeveloped countries, suggests in effect a no-change Budget. In just about five weeks' time we shall know what the Chancellor thinks.

The Engineer—100 Years Ago (MARCH 2, 1860)

" FRICTION OF WATER-PRESSURE ENGINES "

" Captain M. C. Meigs, of the United States government engineers, and engineer of the Washington Aqueduct, gives the following particulars of the working of a water-pressure engine employed by him on that work : ' This engine, drawing its supply from the cast-iron street mains of the Washington Aqueduct, pumps 10,000 gallons of water per hour into a reservoir on the heights of Georgetown, a mile distant, and 204 ft. above the machine. This reservoir supplies that portion of Georgetown which is above the level of the great store and distributing reservoirs of the Washington Aqueduct. In a recent experiment, the engine, using 10,862·2 gallons of water per hour, under an effective pressure of 99·86 ft. as power, pumped 10,410·4 gallons of water against an effective head or resistance of 90·245 ft. This gave an useful effect of ·866 of the power employed ; the loss being absorbed in friction, in producing motion of the parts of the engine and of the water and in leakage, the latter alone being about 2½ per cent. of the water used. By the formula given by Weisbach for the efficiency of the engine alone, the efficiency of the engine and pump being considered equal, 12½ of the total loss of effect being due to the motor, the efficiency of the motor here used is 933, a very high result.' "

Obituary

OLIVER CHADWYCK-HEALEY

WE regret to have to record the death last Wednesday, February 24, of Mr. Oliver Chadwyck-Healey, who was chairman of Morgan Brothers (Publishers), Ltd., proprietors of this journal, from 1948 to 1956. He was seventy-three years old.

It is quite easy to write a factual obituary and we suppose that the facts about a man's life do give some impression of his character. For, in a rough kind of way, there is a correlation between the job a man does and what he is. But the correlation is often very rough and the events of Mr. Oliver's life give little clue to his real personality. He was educated at Eton and Trinity College, Oxford, read Law and was called to the Bar but never practised. He first joined the staff of THE ENGINEER in 1910. In January, 1914, he became a director. After service during the war in the Royal Berkshire Regiment, he came back to THE ENGINEER and was appointed managing director in 1922. On the amalgamation of The Engineer, Ltd., with Morgan Brothers (Publishers), Ltd., he was appointed joint managing director, taking up that position on May 1, 1929. In December, 1942, he became sole managing director, a position which he held until September, 1945. At that time he became deputy chairman of the company and on the retirement of his half-brother, Sir Gerald, in 1948, he was elected chairman. He retired from that office in March, 1956, but remained a director right up to the time of his death.

Mr. Oliver never set out to make himself well known to the staff and consequently he never attained much popularity in this office. But he liked to know, and indeed insisted on knowing, what was going on. To the editors of the firm's journals his most striking quality was a clarity and independence of mind. It was always worth taking a problem to him, even a technical one, because so often he could throw light upon a means of thinking it out. This same independence of mind was brought to bear in the discussion of any subject, for example, of policy, which was before him. He had, too, an almost inhuman detachment. All editors at times receive letters of the kind which begin : " Dear Sir,—We are shocked and surprised that a journal of your standing . . . . . ," and conclude by asking nastily what it is proposed to do about it. There must be few editors who have not got hot under the collar upon reading such a letter and who have not desired to dash off an impetuous and rasping reply. Not so Mr. Oliver when shown such a letter ! No doubt his legal training came to his aid. His temper was completely under control. " Is he right ? " he would ask ; and " What did we print ? " The rudeness and the fury of the correspondent's language would be wholly disregarded. Any action taken must, he insisted, be based upon the real facts and however distasteful it might be to an editor suffering from a sense of cruel insult, a courteously-framed letter must go back.

To younger men this detachment was not a little frightening. Mr. Oliver seemed to be too unemotional to be quite human. But closer contact with him revealed some inward human frailties ; and an attractive, self-mocking humour. Besides, on occasion in what appeared to be a cold and unemotional judgment, he would remark that he didn't think one could really ask someone to behave in some particular way, a conclusion which could in reality have only been reached on emotional grounds ! Upon still closer acquaintance, his vivacity was revealed. Then would come the discovery that he had joined the Board of Management of the Hospital for Sick Children in 1925 and that he had been very active ever since in the management of London hospitals, having at one time as a particular concern the organisation of the Emergency Bed Service. In fact, the better one knew Mr. Oliver, the greater the affection and the esteem one had for him.

Mr. Oliver always kept a sharp look-out on the journals published by the firm and an especially sharp one on THE ENGINEER. He was very quick to spot errors of any kind and particularly those which can so easily be made in quotation. Once, unaccountably, we translated " *Timeo Danaos* " as " I fear the Danes." Mr. Oliver wrote to say that for his part he had always understood it to be the Greeks but that, of course, he stood to be corrected by the editor ! To the very end he kept up this scrutiny. It is the small things in life and death, not the larger ones that prove the more poignant. The thought that we shall never again receive deserved but kindly criticism from that quarter brings sharply home to us the fullness of our loss.

CHARLES COOPER, B.Sc. (Eng.)

WE have learned with regret of the death of Mr. Charles Cooper, which occurred on February 24 at his home at Northwood, Middlesex. Mr. Cooper, who was seventy-six, had spent no less than sixty of his years on the editorial staff of *Engineering*. The only interruption in that long period of service was during the first world war, when, for a time, he had charge of a wind tunnel at St. Albans which was built for the aviation department of Vickers, Ltd. Among the matters with which he was closely concerned there was the wind tunnel work for the design of the " Vimy " bomber.

To his many friends, Charles Cooper delighted to recall that he started his long working life as an office boy with our contemporary, shortly before reaching his fourteenth birthday. But he set himself the aim of matriculation through evening classes at what is now the Chelsea Polytechnic and, having achieved that aim, he went on to take the intermediate examination for an engineering degree. Study for the final examination was delayed for a few years but it was subsequently resumed through evening classes and a correspondence course, his degree being gained in the summer of 1914. From 1919 onwards, Charles Cooper was fully occupied with the editorial work of *Engineering* and from 1939 to 1953 was joint editor of the journal. His special interests included astronomy, the early development of television and the development of scientific instruments generally. For nearly forty years he took an active part in the work of the British Association for the Advancement of Science, especially in the work of the engineering section. He was similarly interested in the work of the Royal Institution and of the Royal Aeronautical Society, of which he was elected an associate fellow in 1918.

We, in company with many others, cherish a long friendship with Charles Cooper. He delighted in conversation and conversation with him was by no means confined to reminiscence ; he was at all times eager to talk about current trends and developments. Above all, Charles Cooper was enthusiastic about the profession of technical journalism, in which he served what must surely be a record term of years. He relinquished daily attendance at his office in 1957, but we think it would be right to say that he never really retired. For we recall an occasion when he told us that that was one of the things he never wanted to do !

G. T. SMITH-CLARKE

CAPTAIN GEORGE THOMAS SMITH-CLARKE, whose death, we regret to note, occurred last Sunday, February 28, was chief engineer of Alvis, Ltd., for nearly thirty years. He was seventy-five. Captain Smith-Clarke was a native of Bewdley and during the first world war he did a great deal of design work on military aircraft. He joined Alvis, Ltd., in 1921 and retired in 1950.

The work that Captain Smith-Clarke accomplished in the years since his retirement has become widely known for it was concerned with the development of various kinds of mechanical appliances to improve medical treatment. He is acknowledged as a pioneer of modern research into mechanical breathing apparatus, particularly the iron lung. Captain Smith-Clarke began this work shortly after the second world war and among his first achievements was the successful modification of the Nuffield Both iron lung to make it a satisfactory mobile equipment. The engineering work involved in this modification and in the design and development of subsequent mechanical breathing machines was described by Captain Smith-Clarke in a James Clayton lecture to the Institution of Mechanical Engineers in 1956 (THE ENGINEER, December 21 and 28, 1956). Shortly after the delivery of the lecture, Captain Smith-Clarke received from the Institution of Mechanical Engineers (of which he was elected a member in 1944) a James Clayton prize. This award was made for the invention, design and development of equipment used in medical practice, including mechanical breathing apparatus, and for the development of mechanisms used in connection with astronomical telescopes. The citation accompanying the award referred also to Captain Smith-Clarke's work associated with aero-engines and automobile engineering.

W. T. LOCKETT

THE death occurred, on February 23, of Mr. William T. Lockett, a former chief chemist of the Middlesex Main Drainage Department and a past-president of the Institute of Sewage Purification. Mr. Lockett who was seventy-three, achieved considerable distinction in the field of sewage purification. Following research work carried out at Manchester with Fowler and Ardern, he discovered, in 1914, the activated sludge process of sewage purification. It was a discovery which can be claimed to have revolutionised sewage treatment ; the process has been adopted by all the largest public health authorities in the world during the last forty years. Mr. Lockett was a graduate of the Honours School of Chemistry of Manchester University ; he obtained his M.Sc. in 1909, later becoming a Fellow of the Chemical Society. He started his career in local government in 1907 with the Manchester Corporation and, apart from the war years, remained there until 1935, when he was appointed chief chemist at the then new Mogden works of the Middlesex County Council.

Charge Face Machinery for Berkeley Nuclear Power Station

The charge face machinery for the two reactors at Berkeley nuclear power station is designed to enable fuel elements and control equipment to be changed, and future fuel requirements to be assessed, while the reactors are on load. Some of the specialised machines for these servicing operations are briefly described here. They are designed and supplied by John Thompson Ordnance Company, Ettingshall, Wolverhampton.

DURING the past three years much of the manufacturing capacity of John Thompson Ordnance Company, Wolverhampton, has been devoted to the making of the charge face machinery for the Berkeley nuclear power station which is being built for the Central Electricity Generating Board by the A.E.I.-John Thompson Nuclear Energy Company, Ltd. Briefly, the functions of this machinery, operating from the charge face on top of the reactor, are to enable fuel elements to be changed as required, control rods to be withdrawn for servicing, visual observation to be made of the fuel channels by closed circuit television, and flux scanning to be carried out to facilitate assessment and programming of future fuel needs. A common requirement in all these functions is that they must be carried out while the reactors are operating on load.

It will be recalled that each of the two reactors at Berkeley consists, essentially, of a cylindrical built-up graphite core about 24ft (732cm) high and polygonal in plan, about 44ft (1340cm) across the flats. The core is enclosed in a cylindrical pressure vessel with domed top and bottom and this pressure vessel is surrounded by a concrete radiation shield. The roof of this shield constitutes the floor of the charge face machine room : access to the reactor core for fuel replacement and servicing is gained through a group of vertical standpipes which penetrate the concrete shield (about 10ft thick) and the pressure vessel. The total height of the charge face above the top of the reactor core is about 40ft. This arrangement is similar in principle to that used at Calder Hall, the main difference, apart from that of size, being that the Berkeley reactor, in common with the other C.E.G.B. nuclear power stations under construction, must be refuelled and serviced on load.

The reactor core contains 3275 vertical fuel element channels arranged on a square lattice of 8in (20·32cm) pitch, as well as 132 control rod and safety rod vertical channels. Each fuel element channel is 4in (10·16cm) diameter with two diametrically opposed longitudinal keyways for the fuel element support struts. Each of the control rod and safety rod channels is 3·35in (8·26cm) in diameter.

The thirteen fuel elements stacked in series in each fuel element channel are supported from the bottom of the core by a deflector or dummy element and a gag. This gag controls the flow of carbon dioxide coolant up the channel. The two main operations to be carried out on the fuel channels are the removal of fuel elements as they near exhaustion and their replacement by new elements, and the changing of a gag, as required, to control the coolant gas flow.

To connect a machine on the charge face with any of the channels in the core use is made of a special articulated chute inserted down the appropriate one of the sixty standpipes. The chute has a vertical axis and is provided with two elbow joints, whereby the bottom limb, while remaining vertical, can be moved radially from the main axis. A spigot on the chute locates the main axis in a reference socket in the top face of the reactor core ; then, by extending the lower limb radially as required and by rotating the chute as a whole, any one of the channels in the swept circle can be accurately located (within 0·22in) and serviced. The articulation of the lower limb on the chute is effected from the machine through a link mechanism.

The main machinery on the charge face floor of each reactor consists of a charge machine, a discharge machine, a chute machine and a control rod and actuator servicing machine (C.R.A.S.M.). As described below, these machines differ in their mechanical arrangements. One point of resemblance is that all the machines are provided with shielding against gamma rays alone or both gamma rays and neutrons. The shielding is mainly lead for the gamma rays and either borated bitumen or polythene chips in oil for the neutrons. As can be seen from the accompanying illustrations, the shielding is graduated to provide maximum protection to the operators working at floor level and much less against upward radiation. The resulting economy in material and weight can be estimated from the fact that the shielding of the control rod and actuator servicing machine (Fig. 4) requires 70 tons of lead and 1200 gallons of borated bitumen.

Another detail common to all machines is that, in the operating position, they must be located on an accurately dimensioned skirt. When the machine is not operating it rests on a parking skirt. The skirts are similar, the main differences being in shielding properties and dimensions.

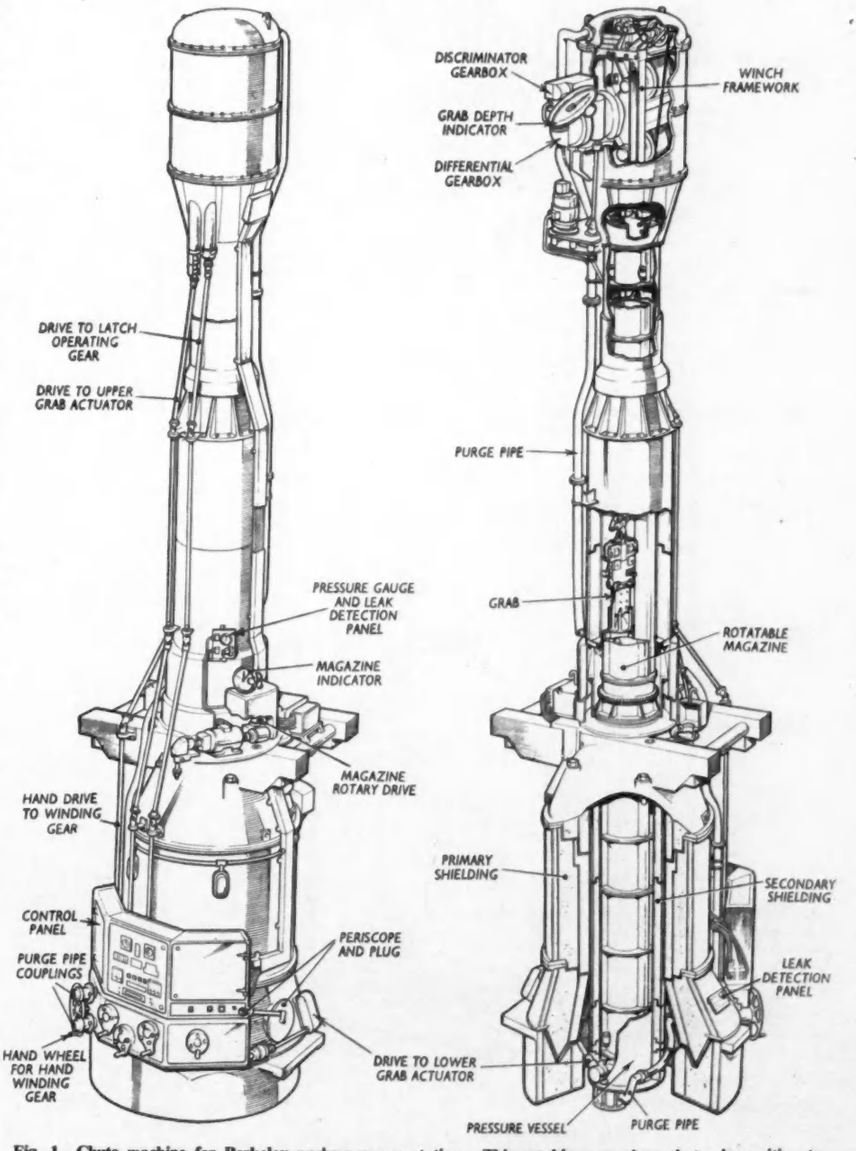


Fig. 1—Chute machine for Berkeley nuclear power station. This machine can place chutes in position to connect the charge face floor with the reactor core

Chute Machine

The chute machine (Fig. 1) which is about 50ft high enables various chutes to be placed in the reactor to serve as a guide along the 40ft gap between the charge face floor and the reactor core.

There are various designs of chute for specific functions, as follows : a charge chute for use with the charge/discharge machine ; a flux scanning chute for use in conjunction with the flux scanning winch ; a fixed absorber chute to be used with the C.R.A.S.M.; a thermocouple chute to operate with its own winch vessel.

The chute machine is equipped with a rotatable three-chambered magazine to store two chutes. These chutes are handled by a grab and winding mechanism which is remotely operated both at the top and bottom of the machine. Two cables support the grab and they are operated by a torque differential gearbox which ensures that the main cable always carries ten-elevenths of the total load while the secondary cable carries the rest. A discriminator gearbox in association with the differential gearbox provides a magslip instrument on the control panel with an accurate reading of the cable stretch at all points on the travel ; it also indicates the instantaneous position of the grab and stops the grab at any point on its travel. The grab is arranged to hold or release its load and to support a released load in the magazine.

As can be seen from the illustration, the grab and magazine are installed in a casing which is pressurised when the chute machine is in operation with the reactor on load. On the outside of the casing are the motor-driven gearboxes that operate the equipment and open or close the standpipe valve. A valve is fitted at the foot of the machine to contain the gas trapped in the casing when the machine is removed from the standpipe. Means are provided for purging and pressurising the machine.

Outside the main shielding that supports the pressure casing is a panel carrying the operating controls and instruments to indicate the state of the machine. The chute machine is placed by the crane on an operational skirt when working over a charge point, over the inspection well, the discharge well, or the decontamination well. Among the interlocks, all of which " fail to safety," and are designed to prevent incorrect operation of the machine, are electrical interlocks whereby lifting cannot be started until the machine and standpipe have been correctly prepared.

Briefly, the sequence of operations is to lift an operational shield skirt and locate it, by means of dowels, over the appropriate standpipe. The machine is then lifted into place on the skirt. Both these lifts are done by the overhead crane. Having made the seal and pressurised the machine, the valve is opened from the control panel and the grab is lowered to engage the shield plug in the mouth of the standpipe. This plug is then lifted and placed in one of the three chambers of the magazine. The grab is then released and the magazine is rotated to allow the grab to engage the chute and lower it into the standpipe. Positioning of the chute is achieved by a spigot at the lower end which engages the appropriate socket on the top face of the core. The chute is then operated from the top, to rotate it and extend the lowest limb as required. After releasing the grab and withdrawing it, the chute machine is purged of gas and removed.

Two chute machines are being supplied

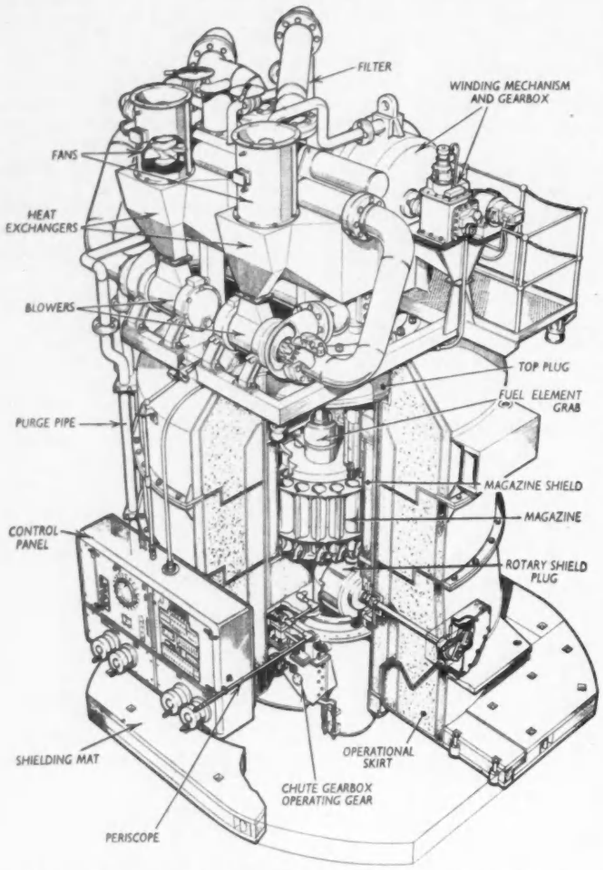


Fig. 2—Charge and discharge machine for handling fuel elements in the Berkeley reactors

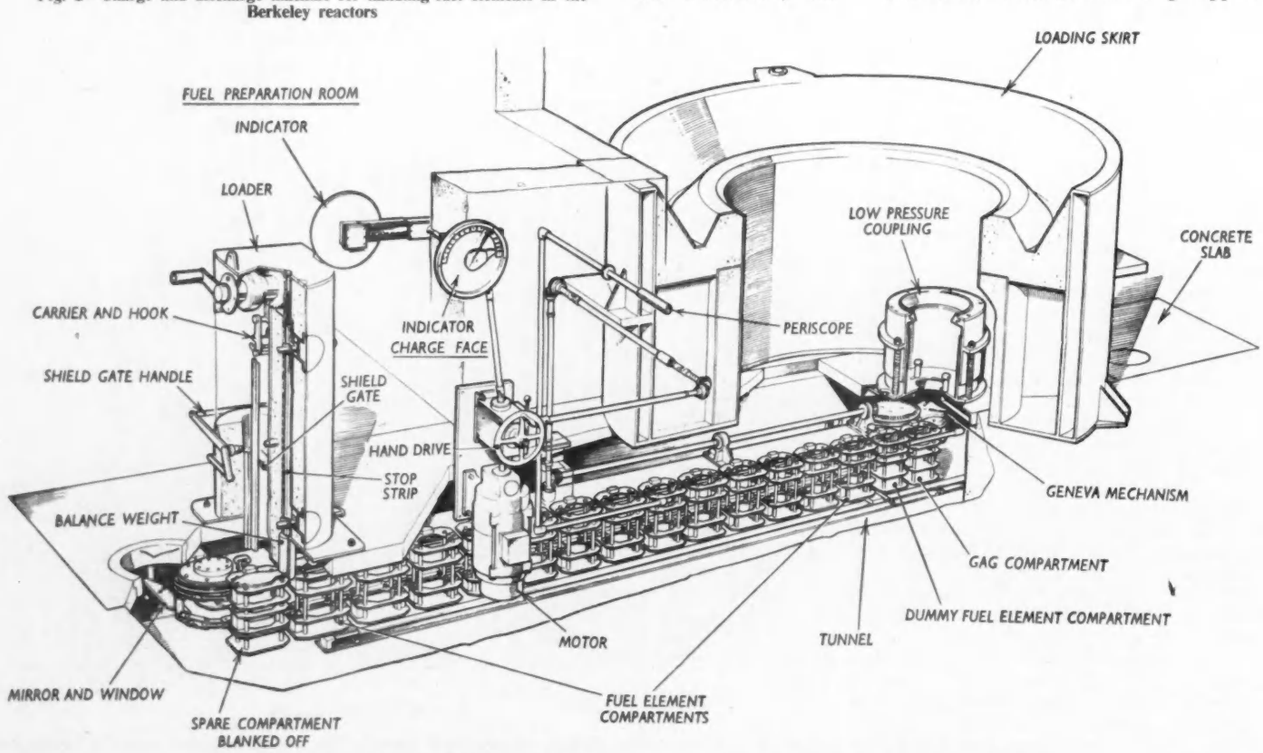


Fig. 3—Fuel element loader and conveyor used in conjunction with charge and discharge machines at Berkeley

for each reactor : one machine, acting as a standby, is not fitted with shielding. The two machines are interchangeable in one shielding.

Charge and Discharge Machines

On each charge face there are two identical machines : one discharges fuel elements from any one of the sixty-four fuel element channels served by a charge chute ; the other inserts the fresh fuel elements via the charge chute. Exhausted fuel elements from the discharge machine are returned to the fuel element reprocessing factory.

Essentially each charge/discharge machine (Fig. 2) is a winding mechanism controlling a grab which can engage a fuel element or release it, as required. The machine contains a rotatable magazine (to accommodate thirteen fuel elements in separate chambers), a reflector, a gag and a spare, and four concrete plugs to seal the chute. Shield plugs are fitted above and below the magazine to reduce the effect of radiation ; in the bottom plug there is a rotary shield to seal off the channel used by the grab. In the bottom of the machine there is a protrudable, geared mechanism to connect with, and control, the fuel element chute when it is in the reactor. All this machinery is enclosed in a pressure casing which is shielded externally.

Instrument wiring and manual and power drives for operating the machinery pass through the pressure vessel and shielding to a control panel on which routine operations can be automatically carried out under the control of relays, uniselector switches and a punched-card programme system. A comprehensive system of mechanical and electrical interlocks prevents actions which may cause damage or be dangerous to personnel.

A forced-circulation cleansing and cooling system is fitted on the top of each charge/discharge machine. Normally it circulates air but CO_2 is substituted when the machine is connected to the reactor. The circulating fans are powered via trailing cables which also power the machine when it is installed on a skirt. When the machine is lifted auxiliary contacts on the crane arms replace the cables to provide enough power for cooling.

To continue the refuelling operation from the point when the chute has been placed in position, as described above, the discharge machine is placed in position on the operating skirt above the appropriate standpipe. Having sealed and pressurised the machine and opened the valve, the gearbox is lowered to engage the head of the chute and the mechanism operating the chute. Then the cycle of operations, which is automatic, is as follows : Zircalloy grab lowered to bottom leg of chute ; leg raised ; grab lowered to engage fuel element ; grab operated ; element lifted to bottom leg and weighed ; chute collapsed, element raised to magazine ; latch lowered ; element lowered ; grab disengaged ; grab raised ; magazine indexed.

This cycle of operations is repeated for the thirteen elements in the channel. The machine also removes and replaces the shield plugs in the chute head and then indicates completion of these operations. It takes about seventy-five minutes to discharge a channel.

Similarly, the charging of a fuel channel from the magazine of a charge machine is done under automatic control. Special operations such as gag changing can be done by sequence button operation or hand control ; each handle has a slipping clutch to limit the torque transmitted.

Fuel Element Loader and Conveyor

Fresh fuel elements are loaded into the magazine of a charge machine by a special equipment (Fig. 3) which consists of a loading skirt, low-pressure coupling, loading conveyor and its loader.

The conveyor consists of two horizontal endless chains passing around four sprocket wheels, each pair on a vertical axle. Supported between the chains are sixteen compartments of approximately the same section as the tube used in the charge machine magazine. Stops fitted in the bottom of the compartment hold the fuel element, which is lowered into them by the loader and raised from them by the fuel element grab in the charge machine. The spacing of the compartments is such that they extend over half of the conveyor only : when the first is under the skirt, the other is under the loader. Five spacers are fitted in the blank portion of the conveyor to maintain the correct spacing between the two chains. A motor and gearbox, mounted on the charge face wall, drives the conveyor.

Basically, the conveyor loader is a roller chain passing over a single sprocket wheel. At one end of the chain is a carrier and hook and, at the other, a cylindrical balance weight. A handle turns the sprocket wheel and a spring-loaded clutch prevents overload. To prevent the element, under its own weight, falling into the conveyor, this spring also loads a brake. The loader casing is made up of one plain tube for the balance weight and another tube of the same section as those in the charge machine magazine ; the latter tube is cut away to allow a fuel element to be inserted. Two flat plates fill in the sides of the casing, which is surrounded by iron-shot concrete shielding in a steel retaining shell.

Control Rod and Actuator Servicing Machine

The Control Rod and Actuator Servicing Machine (C.R.A.S.M.), Fig. 4, is designed to remove for servicing the actuators, control rods, gags and fixed absorbers and to replace the spares. The control rod actuators are winches about 15in diameter and 12ft long, including the shielding plug, and they weigh 15 cwt. They are in the CO_2 pressure system and are secured in the biological shield in specially shaped standpipes. The

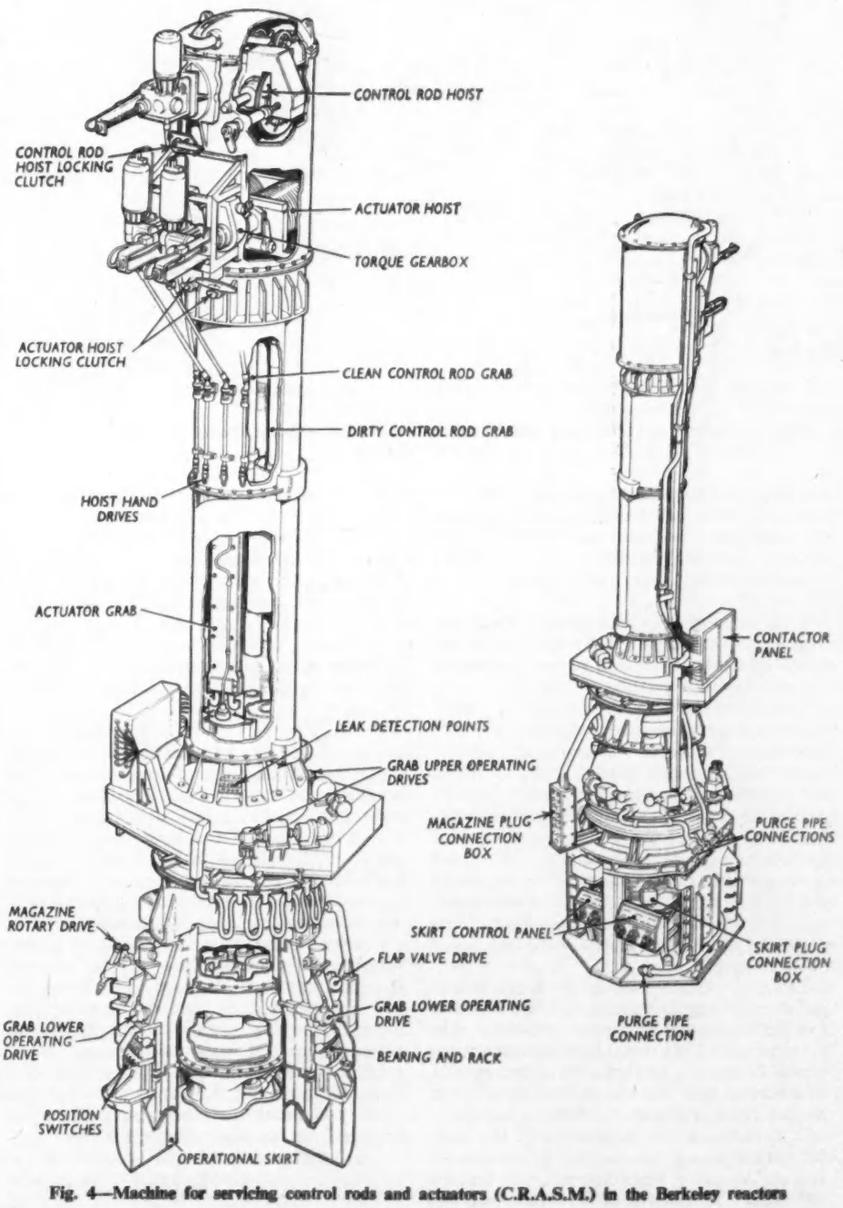


Fig. 4—Machine for servicing control rods and actuators (C.R.A.S.M.) in the Berkeley reactors

method of securing them is by screwed rings which are turned by operating a motor and gear ring, known as the actuator clamping machine. This clamping machine must be attached to the actuator when it is being removed from or replaced in the standpipe.

The C.R.A.S.M. consists of a magazine section containing grabs and their winding gear, and a support, or skirt section complete with various tools, by means of which the actuator can be separated from or connected to its control rod. The skirt section is also used with the "visual observation and recovery equipment" when necessary. Both sections can withstand, either separately or together, the gas pressure in the reactor.

The magazine section is about 40ft high and 5ft in diameter and, together with its shielding, weighs 85 tons. It consists of a pressure vessel containing four magazines and associated equipment. Around the pressure vessel is fitted shielding in a structure by which the main crane can lift the complete unit.

A ball race of 90in diameter on which the pressure vessel and the major portion of the shielding can be rotated in the vertical plane is situated in the shielding structure.

One of the four magazines is for a "clean" (uncontaminated) actuator; one for a "dirty" (radioactive) actuator; one for a "clean" control rod, and one for a "dirty" control rod. Each magazine contains its appropriate grab which is raised or lowered by an independent set of winding gear. The operating gear for winding gears, for grab operation, for rotating shields in the bottom of the magazine, and for four flap valves which seal the vessel, pass through the vessel and shielding. The drive is by electric motor and gearboxes on the outer surface.

The main dimensions of the skirt section and its shielding are about 10ft 6in diameter and 8ft height, and its weight is 65 tons. The pressure vessel has two operating tools; the manipulating tool and the cable recovery tool. The former provides the means whereby the control rod is disconnected from or connected to the cable on the actuator, and the latter supplies a means of recovering the control rod and its cable, should an actuator become defective. To assist in these operations, two periscopes are fitted. A rotary shield and two flap valves seal against radiation and pressure, and a separate sleeve is provided to bridge the gap between the standpipe and the bottom of the skirt.

As a separate unit, the control panel is on a trolley connected by electric cables to the power supply and to both the magazine and skirt sections. When the "visual operation and recovery equipment" is in use with the skirt section, the control panel links the skirt and control panel on the recovery equipment.

The skirt, placed by the crane over either an actuator standpipe or a charge standpipe, rests flat on the charge floor plates and the connection to the standpipe is made by the appropriate sleeve. For conducting operations on the reactor the magazine can be placed on a skirt; it is placed on an operational skirt over the inspection well or the chute decontamination hole for reloading or discharging. It can be positioned on any of the skirts on the charge face floor and electric interlocks prevent either magazine or skirt being lifted unless properly prepared. Similarly, interlocks prevent incorrect operation and are all designed to "fail to safety."

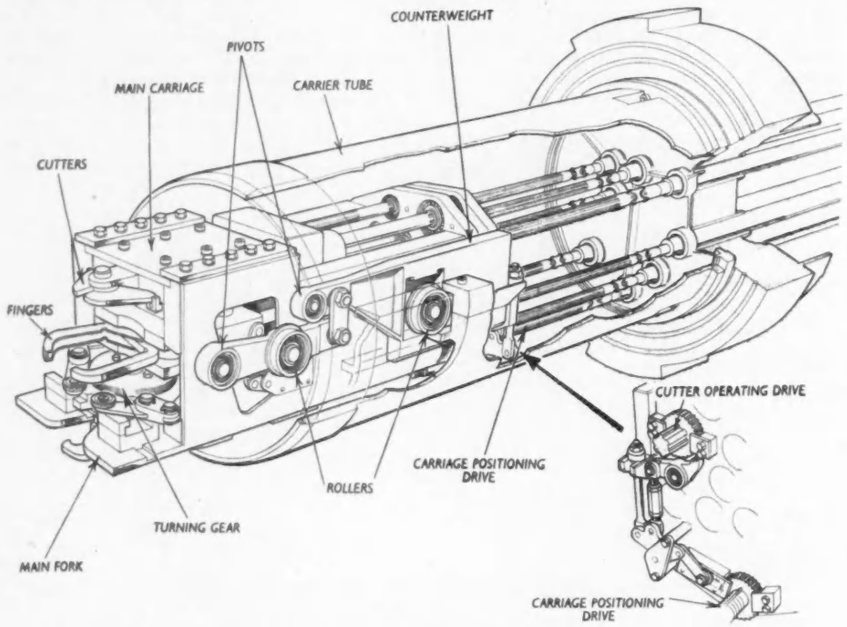


Fig. 5—Control rod manipulating tool to work in conjunction with the Control Rod and Actuator Servicing Machine

Control Rod Manipulating Tool

The control rod manipulating tool (Fig. 5) fits into the skirt pressure vessel through the lower of the flanged tubes for tools. It is horizontal and can be extended to move into the vertical line of the hoist on the standpipe. It is designed to enable the actuator cable to be disconnected from, or connected to, a control rod under all circumstances. The manipulating tool supports the control rod when these operations are being performed, but cannot release it until the rod is again otherwise supported. When the rod is supported on the tool, turning gear engages it to turn it to the correct disengaging or engaging position, and crooked fingers seize the ball and fitting, either on the cable from the actuator, or from the control rod grab, and move it, thus causing it to disengage from, or engage with, the rod.

The manipulating tool constitutes an internal section contained inside the pressure vessel, a centre section to provide shielding, and an external part consisting of control panel and gearbox assembly; it is fitted with seven drives passing through its gearbox. The drives are to extend or retract the carriage of the internal section; to grip or clear the ball socket fitting; to turn the ball socket fitting to the disc or engage position; to seize the cable ball-end; to move the cable ball-end vertically and horizontally to disengage, or engage the ball socket fitting; to position the cable cutter; and to cut the cable.

The three interlocks with which the machine is fitted prevent the carriage of the internal section being retracted when it is supporting a control rod; prevent release of the ball socket fitting, unless the main body of the control rod is supported; and prevent the cutting of the cable unless the control rod is supported.

Other Machines

Flux-Scanning Winch.—Deductions about the programming of fuel element changing can be made with the help of flux-scanning observations and records. Flux scanning is carried out by flux-scanning winch mechanisms of which twenty-six are being supplied for each reactor at Berkeley. Used in conjunction with a flux-scanning chute, each winch lowers a tungsten wire into the reactor core, where the wire absorbs radioactivity at a rate that depends on the condition of the neighbouring fuel elements. After raising the wire it enters a shielded compartment in the winch and a count is made of the radioactivity of the wire. This count is recorded graphically and similar recordings are made simultaneously at different parts of the reactor core. Programming needs can be assessed from a study of these recordings.

Visual Observation and Removal Equipment (V.O.R.E.).—The charge face machinery includes equipment for visual observation through closed circuit television. Below the camera there is a grab (a variety of grabs is available for different recovery jobs). The grab can be lowered down a chute into any fuel element channel or control rod channel. Parts of a broken fuel element or other fragments can be recovered and stowed (for disposal later) in a twenty-channel magazine which is similar to that of a charge and discharge machine. All the operations are carried out by remote control from a desk mounted on a platform on the outside of the machine: these operations are selection of the grab and its attachment to the camera; operation of the grab, camera, chute, and stowage magazine. Because of limitations in the use of the television camera under radioactivity, this machine can only be used when the reactor is operating at a low rate.

Support Skirts

With the exception of the C.R.A.S.M. skirt, which itself is a pressure vessel, all skirts are, basically, support structures. Semi-permanent support skirts for the loading conveyor, for the discharge well, and for both low and high parking, are provided for each reactor, which also has three movable operational skirts. The design of support skirts varies only in shielding requirements and overall height.

Loading Conveyor Skirt.—This skirt is semi-permanently positioned over the loading conveyor to locate and support the charge machine when it is being refilled. It is 5ft 3in high and contains 15½in of iron-shot concrete in its walls. A separate platform on the outside gives access to the machine's controls.

Discharge Well Skirt.—This equipment is

semi-permanently positioned over the discharge well and the adjacent chute decontamination hole ; the skirt locates and supports the discharge machine, the chute machine, the visual observation and recovery equipment (V.O.R.E.), the chute mechanism, and the C.R.A.S.M. magazine for discharging. The skirt is 2ft 6in high and contains 4in of lead and 19¼in of iron-shot concrete in its walls.

Low Parking Skirt.—This unit is semi-permanently positioned near the entrance to the maintenance bay. It is 2ft 6in high, but its walls have no shielding.

High-Parking Skirt.—Semi-permanently positioned near to the low parking skirt, this unit can accept any machine. It is 7ft 1¼in high and its walls contain 8in of lead and 11⅞in of iron-shot concrete. Inside it are guides, provided to enable the crane to position the skirt as required.

Operational Skirt.—This skirt is positioned where required on the charge face floor and can accept any machine. Its walls contain 16¼in of borated polythene surrounded by 3in of lead and the unit is 2ft 6in high. Header tanks, connected permanently to the polythene-filled ring, accommodate the expansion or contraction of the polythene mixture under extremes of temperature. Air release plugs are screwed to the top of the skirt and pads at the base allow the attachment of dowel brackets for location over the inspection well, &c. Friction pads are fitted on the bottom surface to prevent movement while the skirt is resting on the floor and extra shielding, in the form of borated hydroboard enclosed in fabricated plating, extends outside the bottom of the ring. Part of this material is hinged to allow the engagement of the crane forks with the lifting lugs. It must be replaced, level, after the crane has disengaged. Extra sections are fitted on the floor to make up a roughly square mat of shielding after the skirt has been positioned.

The two dowel pin holes on the top of the skirt, in which the pins on the machine engage to give correct alignment, can be adjusted in the horizontal plane.

Motorway Junctions

(*Contributed*)

ERUDITE, wide-ranging views on motorway junctions engaged the Institution of Civil Engineers Traffic Engineering Study Group for nearly three hours on February 23, when Mr. J. G. Smith, M.I.C.E., Deputy Chief Engineer for Motorway Works, Ministry of Transport, presented for discussion a paper entitled " Junction Design on Motorways." Yet again, as one has come to expect of this vigorous group, the attendance was around the 300 mark, including many drawn from far afield, certainly from the full length of Britain's motorway territory ; for, between them, the score or so of speakers must have flashed on the screen nearly every British motorway junction, some more than once, and they didn't stop there ; a Texan multi-level interchange crowned the display, though one sensed that many of the audience were content to view it as a dream—or nightmare ! These monthly T.E.S.G. discussions certainly cover their subject.

Junctions are spacious things, and costly ; that came out vividly enough during the evening. The simplest " trumpet " type of T-junction, with a single bridge, might occupy 13 acres and cost £71,000 ; the type that is coming to be regarded as the normal British one, with overhead roundabout and a pair of bridges, might occupy up to 20 acres and cost from £115,000 to £180,000 ; a full-scale clover-leaf might occupy 45 acres and cost £300,000. All in all, with junctions, the typical motorway averages some 20 acres per mile. In the face of such acreages it was perhaps only to be expected that the old, agricultural-land conflict should have burdened certain of the evening's speakers. For their relief, however, there can always be quoted no less an authority than the Director of the Agricultural Economics Research Institute, one of whose typical pronouncements, recorded at the 1957 Highways Conference, was to the effect that there was a scare about the use of agricultural land for roads that should, in his view, be ignored ; the amounts of agricultural production involved were trivial in comparison. There indeed is a pass sold ; do let the most be made of it. The nice problem remains, however, of what to do with the 3 acres completely encircled by each slip road in certain designs of junction. To judge from the slides shown during the evening the height of ingenuity so far attained has been to leave undemolished within the circle one straggly piece of hedgerow to relieve the landscape !

In addition to the acreages required the costliness of the construction of junctions helped to oppress the meeting somewhat in its early stages. Mr. Smith had written, " It is desirable that the number of junctions should be kept to a minimum," and he had read that out, loud and clear, when opening the proceedings. The 72-mile London–Birmingham motorway has ten junctions ; the 28 miles between the Ross Spur and the South of Birmingham will have four ; it seems likely that the average spacing throughout the country will be about 7 miles ; but there may be spacings of up to 12 or 14 miles, and the very minimum should be about 3 miles to allow for the merging of traffic between junctions and for sign-boarding. Because of those pronouncements, no doubt, it was almost apologetically that the meeting was soon told of two junctions only 760 yards apart in the clear, which were functioning well enough. Then it had to be confessed that on one 10-mile stretch there were three junctions ; but this extravagance did have the merit of facilitating the first aid arrangements. Finally, it was somehow made to seem almost reprehensible that two consecutive junctions happened to be so located as to entice commuter-motorists into using the short stretch of motorway between them as a sort of by-pass!

Those commuter-motorists mark a convenient stage at which to notice how truly these T.E.S.G. meetings run to form with all professional meetings, of all the professions, in making only scant mention of the general public, and then sometimes merely to imply that they are rather a nuisance.

To revert to the proceedings of February 23 : one of the speakers emphasised, very pertinently, the advantages of a depressed or " dished " site for a junction, in that it gave the approaching driver a good view of the layout ; but he soliloquised that perhaps, after all, the best sites for junctions were where the public wanted them. The next speaker, however, promptly brought the meeting back to Square One, strongly supporting the Ministry's views on the spacing out of junctions, and there followed a period of discussion on certain engrossing features of junction design, of which these are a sample :

(*a*) Whether acceleration lanes should be of the same length as deceleration lanes, or longer, or shorter.

(*b*) Whether a diamond design can be trusted to serve for more than a very lightly trafficked junction.

(*c*) Whether the form of construction should be governed by economy of land, or of money.

(*d*) Whether twin-carriageway slip roads deserved their place in certain designs of junction, and, if so, how should they be sign-boarded.

(*e*) Whether any feature should be incorporated in the layout, howsoever meritorious, if it did not lend itself to sign-boarding.

(*f*) Whether the Americans are right in eschewing roundabouts.

(*g*) Whether it is better to terminate a motorway with a roundabout than by providing a final fly-over junction with the highway system.

Presently the sequence was broken by a quiet contribution that, in retrospect, one feels can best be described as coming from the British taxpayer, or motorist, or whatever he may be called ; though in fact—praise be !—it came from the lips of a highway engineer. The meeting should not forget that motorways were there to be used—to be used by the public, who paid for them ; junctions should be spaced, not theoretically, but practically, to serve the community to the utmost ; wherever highway traffic surveys revealed a demand for a junction, there should a junction be provided, and sometimes it would be justifiable to have an eye to posterity and anticipate a demand in this era of rapidly expanding traffic.

From then on we (you, Sir, and your contributor) as motorists and taxpayers were accorded some place among the slip roads, sign-boards and radii of curvature, and it transpired that, as motorway drivers, we are just the usual mixture ; no amount of sign-boarding or other mollycoddling will keep us right every time, and we don't expect it ! We take our turning rather late and fast, or miss it altogether and go on to the next, with good grace ; and sometimes we charge the final roundabout (too small at 70ft radius?) ; but nevertheless we have already, in spite of a wintry novitiate, achieved a motorway safety record better than that of the Germans on their autobahns, and accordingly a long way better than our own highway record. On behalf of both of us—if he may—your contributor belatedly acknowledges that little tribute, and takes the opportunity of adding something that was not out of accord finally with the overall tenor of the discussion, which is that we do not wish highway and traffic engineers to overstrain themselves producing super-perfection, slowly ; we just want motor roads, and access to them, quickly.

It remains to record that in conclusion the author of the evening's paper gave a model summing-up of the discussion, rounding off the proceedings with authority and statesmanship. On the particular question of whether the number of junctions, giving access from the highways on to the motorways, should be a minimum or a maximum, the land problem led him to sound only the familiar knell, about hands being tied. However, he did venture the figure of 800 miles of motorway.

The Fairlie Locomotive

ITS USE THROUGHOUT THE WORLD

By R. A. S. ABBOTT, Member, Newcomen Society

No. II—(*Continued from page 355, February 26*)

The history of the Fairlie locomotive, although of great technical interest, is a subject that has never received due attention from engineering historians, and the literature relating to this particular phase of locomotive development is extremely limited and is mainly confined to isolated references in early periodicals. When the history of the seventeen Fairlie locomotives that have operated on railways in Great Britain and Ireland was published in "The Engineer" of December 5, 1958, the author expressed the hope that at some future date he would be able to deal with the use of this type of locomotive in other parts of the world. Now, as much hitherto unpublished information has recently been released from official sources both in Great Britain and overseas, it has become possible to present for the first time a more comprehensive survey of the world use of the Fairlie locomotive.

EIGHTEEN locomotives of the 0–6–4 single-boiler Fairlie pattern were supplied to the order of the New Zealand Government Railways, who saw in this type a design that would solve many operating problems. Of these, fifteen (Works Nos. 1217–1231) were built in 1878 followed by three more (Works Nos. 1232–1234) during 1879. It is understood that the Avonside Engine Company was given the contract on the recommendation of Robert Fairlie, and the price per engine was £1840. These locomotives were officially known as Class "R" and had cylinders 12½in diameter by 16in stroke with Walschaerts valve gear; coupled wheels 3ft in diameter; coupled wheelbase 6ft 9in, with bogie pivot 6in to the rear of centre axle; distance between pivots of front and rear bogies 15ft 8½in; trailing bogie wheels 3ft in diameter on a wheelbase of 4ft 6in. The total heating surface was 608 square feet and the grate area 12 square feet. Boiler pressure 130 lb per square inch. The water tanks held 716 gallons.

Some of these locomotives were fitted with a most peculiar form of feed water heater; in this system, hot ashes were caught in a large balloon type chimney and blown down a short external pipe (near the base of the chimney) into the side tanks, and were then ejected through a larger pipe which discharged into the air near the back rim of the chimney. A photograph of one of these engines so equipped will be found on page 9 of *The Locomotive* for 1921.

This class was followed immediately by a further series of seven almost identical engines designated "S," due to the cylinders having a diameter of 13in instead of 12½in. Four appeared in 1880 (Works Nos. 1279–1282) and three in 1881 (Works Nos. 1283–1285), although due to primitive workshop facilities in New Zealand it was 1886 before the last engine had been erected. These "S" class locomotives were illustrated in THE ENGINEER for January 30, 1959, page 180. In 1891 three of these were sold to the West Australian Government Railways for use on the old Eastern Main Line of that system. All three were scrapped in 1900. With their small coupled wheels the "R" and "S" classes had been primarily designed to haul mixed trains at speeds of about 25 m.p.h., but in service they proved capable of attaining speeds of up to 53 m.p.h. These single-boiler Fairlies were very successful engines, and some of the "R" series remained in Government service until the nineteen-thirties, while two that had been sold to private owners were at work as recently as 1945. The last of the "S" class was scrapped in 1926.

One 0–6–6–0 locomotive (Works Nos. 1237–8) was built during 1878 for the 3ft 6in gauge lines of the Cape Government Railways in South Africa. The following dimensions have been taken from the general arrangement drawing, but no photograph has been found. The cylinders had a diameter of 11½in with a stroke of 18in, the valves being operated by Walschaerts gear. The wheels had a diameter of 3ft 3½in, the bogie wheelbase 7ft 6in and the total wheelbase 25ft. The bogie pivots were located 3in to the firebox side of the centre axles and were 17ft apart. Each boiler barrel had a length of 10ft and a diameter of 3ft 11½in, the tube heating surface amounting to 908 square feet. With 90 square feet provided by the fireboxes the total heating surface was 998 square feet. Grate area 14 square feet. The tanks held 840 gallons, and the capacity of the coke bunkers was 42 cubic feet. The sandboxes were located round the base of each chimney.

The first railway to be opened by the West Australian Government was from Geralton to Northampton, over 300 miles from Perth, the state capital. The railway itself was 33 miles in length and was primarily a mineral line. To work this isolated system two Fairlie locomotives of the unusual 2–4–4–2 type were purchased in 1879 (Works Nos. 1239–1242) (Fig. 11). These had cylinders 10in in diameter by 18in stroke; leading wheels 2ft in diameter; coupled wheels 3ft 3in in diameter. Wheelbase, leading wheels to front coupled axle, 5ft; coupled wheelbase 5ft; total wheelbase 30ft 6in. The bogie pivots, located 1ft 9in from the front coupled axle, were large hollow spheres 12in diameter resting in cup-shaped sockets on the bogie cross-members; the distance between the two was 17ft.

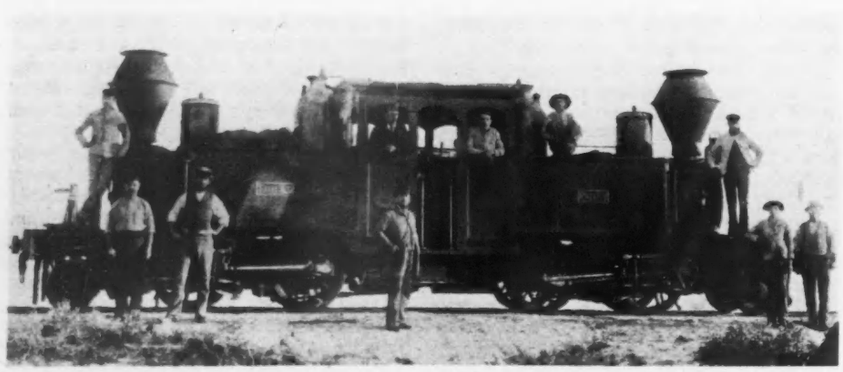


Fig. 11—West Australian Government Railways: locomotive built in 1879 by the Avonside Engine Company

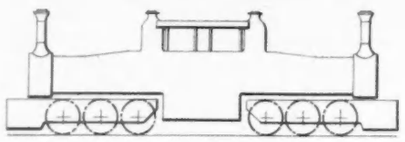


Fig. 12—Diagram of locomotive for the Iquique Railway, Peru, *circa* 1874

Avonside Works Nos. 1245–1278 were allotted to a series of 1·7m gauge locomotives of the 0–4–4–0 type built in 1880 and 1881. Of these, seven went to the North Western State Railway of India and ten to the Burma Railways. The only details available are that the cylinders were 11in in diameter by 17in stroke, with Walschaerts valve gear, and the wheels had a diameter of 3ft. In 1908, to work the adhesion section of the Nilgiri Mountain Railway between Coonoor (altitude 5613ft) and Oatacomund (altitude 7228ft), a distance of 12 miles, the South Indian Railway purchased four of the above locomotives from the North Western State Railway. Due, however, to the advent of new motive power, these were only used for a few years, and one had been withdrawn in 1914. A photograph of one of these engines when in service on the Nilgiri Mountain Railway appeared in *The Locomotive* for 1914, page 288.

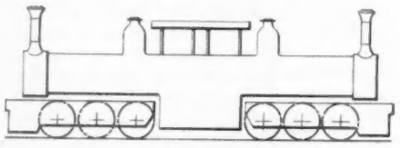


Fig. 13—Diagram of locomotive for the Iquique Railway, Peru, *circa* 1874

It will be convenient at this point to consider a number of Fairlie locomotives whose makers and actual dates of construction are not known, although it is probable that most, if not all, of them came from the works of the Avonside Engine Company, but, as already mentioned, the existing records of that firm are very incomplete and much

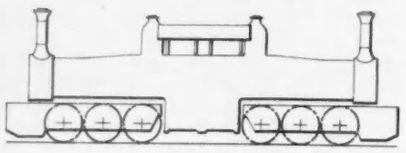


Fig. 14—Diagram of locomotive for the Pisagua Railway, Peru, *circa* 1874

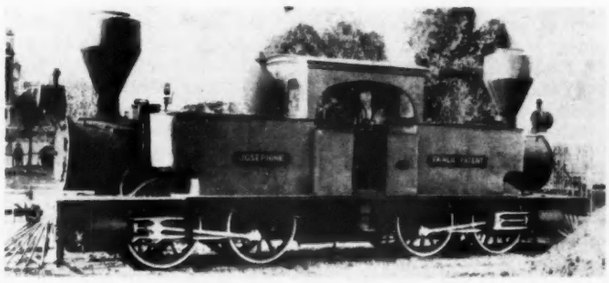


Fig. 15—The "Josephine," built 1872 for the Dunedin and Port Chalmers Railway, New Zealand, by the Vulcan Foundry, Ltd.

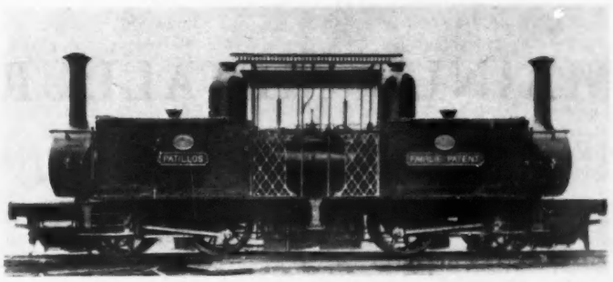


Fig. 16—The "Patillos," built 1872 by the Vulcan Foundry, Ltd., for the Patillos Railway, Peru

valuable information regarding their early engines has been destroyed.

The Credit Valley Railway in Canada is said, by Robert Fairlie in his article published in 1876, to have had double-boiler locomotives in use at that date, while there is a reference in *Engineering* for August 21, 1874, to the effect that due to the fine performance of the Fairlie engines on the Toronto, Grey and Bruce Railway, the president of the Credit Valley Railway had decided to use the type for the heavy traffic of this line.

The Iquique Railway, Peru, possessed two classes of 0–6–6–0 locomotives in addition to those already described. These were built about 1874 and fortunately diagrams exist of both series, together with the leading dimensions. The engine illustrated by Fig. 12 had cylinders 15½in in diameter by 20in stroke ; wheels 3ft 6in diameter ; bogie wheelbase 8ft ; total wheelbase 28ft 11½in. The total heating surface was 1725 square feet and the grate area 26 square feet. Capacity of water tanks 2100 gallons. The coal bunkers held 2 tons. The other series, Fig. 13, had cylinders 15in in diameter by 20in stroke ; wheels 3ft 6in in diameter ; bogie wheelbase 7ft 8in ; total wheelbase 27ft 11in. The total heating surface amounted to 1600 square feet. The water tanks held 2000 gallons, and the bunker capacity was 2 tons.

The diagram, Fig. 14, represents a class of locomotive in use on the Pisagua Railway in Peru about 1874. The engines were large and had cylinders 17in in diameter by 22in stroke ; wheels 3ft 9in diameter ; bogie wheelbase 8ft 6in ; total wheelbase 31ft 10¾in. The total heating surface was 2059 square feet, with a grate area of 33·82 square feet. The water tanks held 2600 gallons, and the coal bunkers 2 tons 10 cwt.

Three other railways in Peru were reported to be using Fairlie locomotives by March, 1876 ; these were the Chimbote-Huaraz, the Lima-Oroya and the Tarapaca Junction, but no details of their locomotives have been found.

During the year 1875 a 0–4–4–0 locomotive was put into service on the narrow-gauge Matanzas Railway, Havana, in the Island of Cuba. This engine was constructed to the same general arrangement drawings as the "James Spooner" on the Festiniog Railway, so it is quite possible that the Avonside Engine Company was the builder. The cylinders, bogie wheelbase, total wheelbase and wheel diameter were identical with the "James Spooner," but the tube heating surface amounted to 536 square feet, the firebox heating surface was 58 square feet, making a total of 594 square feet. The tanks held 600 gallons and the total weight was 21 tons. The gauge of this railway was 2ft 6in.

The Vulcan Foundry, Ltd., Newton-le-Willows

The first two Fairlie locomotives to be built by the Vulcan Foundry were for the 3ft 6in gauge Dunedin and Port Chalmers Railway, New Zealand, in 1872. These were of the 0–4–4–0 type (Works Nos. 636 and 637), being named "Rose" and "Josephine," Fig. 15. The cylinders were 10in in diameter by 18in stroke ; wheels 3ft 9in diameter ; bogie wheelbase 5ft ; total wheelbase 19ft 9in. The boiler barrels had a length of 8ft 6in and a diameter of 3ft 9¼in, the tube heating surface being 759 square feet, and that of the fireboxes 70 square feet, making a total of 829 square feet. Grate area 10·25 square feet. Boiler pressure 130 lb per square inch. The water tanks held 890 gallons and the coal bunkers 17 cwt.

In 1876 both locomotives were taken into the stock of the New Zealand Government Railways and the "Rose" ceased work during the 1880s, but "Josephine" had a much longer and varied existence. It was sold in 1900 to the Public Works Department and used on construction work until 1907, afterwards being laid aside in a shed at Mangaweka until 1917, when it was disposed of to the Otago Iron Rolling Mills for scrap. Fortunately it was not broken up and so was overhauled and reconditioned during 1925 for the Dunedin and South Seas Exhibition, and the photograph shows this locomotive outside the Otago Early Settlers Hall, where it has been on permanent display since that date. The large balloon funnels are not original and were only fitted in 1925.

The Patillos Railway, a 2ft 6in gauge line in Peru, received two 0–4–4–0 locomotives in 1872 (Works Nos. 638 and 639) and these were named "Patillos" and "Sagumas," Fig. 16. Except for the gauge and a bunker capacity of 1 cwt less, the dimensions were identical to those of the New Zealand locomotives.

When General Palmer carried the 3ft gauge track of the Denver and Rio Grande Railroad through the La Veta Pass, Colorado, at an altitude of 4700ft, on its way from Denver to Mexico City via Santa Fe, with grades of up to 211ft per mile, the physical characteristics of this line were thought to be very favourable to the use of the Fairlie type. The engine illustrated by Fig. 17 was built in 1873 (Works No. 672) and is said to have been ordered by the Duke of Sutherland, who presented it to the railroad company. The "Mountaineer" was a wood burner, weighing 29 tons 10 cwt in working order, and was fitted with the Le Chatelier counter pressure brake. It was withdrawn from service in 1883.

Following this came three 0–4–4–0 locomotives for the Pimental and Chicklaya Railway, a line of 3ft gauge in Peru. These engines (Fig. 18) were named "Chicklaya," "Pimentel" and "Batta" respectively, and were numbered 678–680 in the maker's books. These three locomotives, together with the one for Colorado, were all built to the same general dimensions as those for New Zealand and the Patillos Railway.

(*To be continued*)

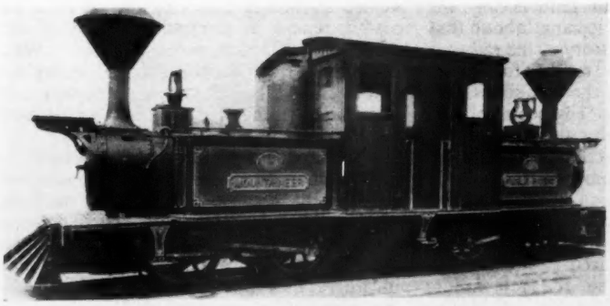


Fig. 17—The "Mountaineer," built by the Vulcan Foundry, Ltd., for the Denver and Rio Grande Railroad, U.S.A., in 1873

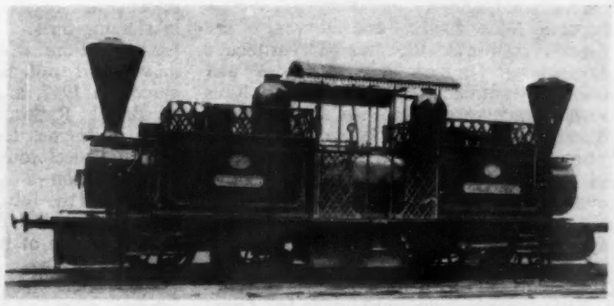


Fig. 18—The "Pimentel," built by the Vulcan Foundry, Ltd., in 1873 for the Pimental and Chicklaya Railway, Peru

MAINLY METALLURGY

by T. Henry Turner, M.I.Mech.E. M.I.Loco.E. A.R.Ae.S. F.I.M.

Railway Rails

Until recently the main lines of Great Britain were almost all laid with 60ft long bull head section, medium manganese composition, steel rails of 95 lb weight per yard length.

British Standards for Rails.—The issue of B.S. No. 11 : 1959 (see THE ENGINEER for February 5, 1960, page 223) brought into being a completely new series of railway rails, with weights ranging from 65 lb to 110 lb per yard, to be referred to as the "A" Series. Satisfactory experience with the British Railways 109 lb per yard flat bottomed rail in 7000 miles of the most heavily loaded tracks in Great Britain led the British Standards Institution to adopt it as the basis of design for B.S. 110A, and indeed for the whole of the "A" Series. With minor adjustments to meet Continental requirements, it has also been adopted by the International Union of Railways for their U.I.C. 54 kg per metre rail.

This move towards uniformity of design may have unexpectedly far-reaching effects in permitting co-operation and competition. The chemical composition and mechanical properties of the new rail sections are little different from those of the rails recently rolled for British Railways but changes in steelmaking practices, which are now taking place in all steelmaking countries, may in time prove to influence the wear and service life of steel rails.

The standardisation of rail wear measurements and the standardisation of the methods of reporting rail failure details will help to pin-point the effects as the years go by. From this statistical investigation point of view, it is unfortunate that all railways are changing their modes of traction, and sizes of driving wheels, so that even with the standardisation of records it will still be difficult to make the essential comparisons in future years. It may come as a surprise to many that the effectiveness of the Clean Air Act will be one of the major features determining the life of steel rails in this country in the future, and that is because rail wear is the rubbing away of rust, and atmospheric pollution increases the rate of formation of rust and therefore the rate at which it is rubbed off the rails.

The Strength of Rails.—At the Institution of Mechanical Engineers, on January 13, 1960, a paper by Wise, Lindsay and Duncan, of the British Railways Research Department's Engineering Division, was presented and discussed, entitled "The Strength of Rails with particular reference to Rail Joints." The classic papers on rails are to be found printed in the *Proceedings* of the Institution of Civil Engineers. Looking through a complete set of these old papers, one notes with surprise the intense interest exhibited in the subject about the turn of the century, when the discussions often lasted several days and were reported verbatim.

Other papers on rails will be found appropriately in the *Journal* of the Permanent Way Institution, a much younger body, founded in 1884 and incorporated in 1908. In its *Jubilee Journal*, dated August, 1959, there was a paper on "The Maintenance of Long Welded Rails." Later this session, the Permanent Way Institution is to hear a paper, next monday, on the "Ultrasonic Detection of Rail Flaws," and in December a paper on "Handling and Maintenance of Long Welded Rails" : both being subjects of great importance to the railways of the future.

Reverting to the paper, "... with particular reference to Rail Joints," the Institution of Mechanical Engineers no doubt considered it because steel rails would last a century or more but for the mechanical wear and tear caused by rail vehicles, and the extraordinary corrosion caused by the steam locomotive boiler feed-water pick-up troughs splashing, and the addition to the atmosphere of tunnels of steam and sulphurous smoke and grit from coal-burning locomotives, which greatly increase the rapidity of the corrosion of steel rails.

The paper described the work carried out by the Research Department of British Railways and consisted of three parts. The first part gave some details of the present B.S. No. 9 bull head, and B.S. No. 11 flat bottomed rails. Before nationalisation killed them, the four group railways, covering all Great Britain, had agreed and were all using the former L.N.E.R. medium manganese chemical composition for the steel of their standard 60ft long, 95 lb per yard bull head rails.

Rail Failure Statistics.—By 1947 the group railway chief civil engineers had also agreed to follow the L.N.E.R. methods of examining and reporting rail failures, and at the suggestion of that railway, they had drawn up an all-country rail failure reporting, description and classification booklet which was soon in the pockets of all the permanent way inspectors and district engineers. In this booklet there were twenty-one plates of photographs illustrating the rail defects which had been observed in service in the tracks.

Previously the railways had been required to report only certain classes of rail failures to the Minister of Transport, and for the remainder of the defects and failures there was no agreed method of reporting, the different railways adopting their different methods. But to get the maximum benefit from such reports the engineers needed full information regarding all failures of rails in running lines. Thus it came about that for the first time in the history of the railways a standard rail failure report form was agreed in 1947, and on the nationalisation of British Railways the engineers of the new six Regions took over this informative new statistical tool, which has already led to a reduction in the number of rail failures. Ever since the introduction of the standard rail failure report forms in 1948 the Metallurgy Division of British Railways Research Department has produced annual summaries after studying all the rail failure reports from all six Regions of British Railways.

Now that throughout Europe the rail sections and compositions are becoming more similar this British Railways method, with a decade of experience behind it, may be modified to permit easier comparison with Continental experience. Part I of the paper by Wise, Lindsay and Duncan therefore quotes and considers this 1947 rail failure classification and some of the figures from the Metallurgy Division Reports up to 1955. Just why they have not referred to the more interesting later reports is not explained. Part II describes investigations made on the track to measure the dynamic stresses experienced by rail joints under traffic.

Corrosion Fatigue of Rails.—The third part of the same paper describes fatigue tests which have been made on B.H. and F.B. rails, both plain and when drilled with fishplate holes. It was not explained why it was thought necessary to carry out these tests. One had seen similar laboratory fatigue tests being carried out on F.B. rails in Charlottenburg more than twenty years earlier. However, one of their findings appears to be novel and deserves notice. These British Railway research workers found that the fatigue strength of new rails with holes drilled in them for fishplates may be improved 50 per cent by a simple work hardening of the surface by pushing a suitable expanding tool through the holes. Ordinary atmospheric corrosion reduces the fatigue strength of rails from ± 10 tons per square inch to ± 7 tons per square inch, but very fortunately the gain in strength due to the cold working of the fishplate holes is only slightly reduced by exposure to corrosion. This third section of the paper has therefore pointed to a practical improvement in rails, and as a result British Railways are now having rail fishplate bolt holes work-hardened in this manner at the manufacturer's steel rolling mills.

In concluding the introduction of the paper Mr. S. Wise summed up by saying that "All this amounts to a very good case for welding rails and getting rid of joints as far as possible." Some have preached this in season and out of season for more than twenty-five years, and Mr. G. W. King in opening the discussion said that long welded rails, laid on concrete sleepers, would be the standard practice for main lines in the future. More than half of the London Transport Executive's 150 miles of long welded track is in the open air, yet its extra cost is repaid in six years because of the reduction in maintenance failures. Why then have British Railways lagged so noticeably behind the Continental railways in introducing long lengths of butt-welded rails ?

Fishplated rail joints mean trouble in maintenance and the need for premature replacement because of the many millions of bolt holes. Moreover, corrosion so increases the depreciation of the track that when the mechanical engineers were unlucky in where they put their locomotive boiler blowdown water on the L.M.S.R. their civil engineers claimed to be losing £500,000 a year due to increased track maintenance. Someone was segregated to cure the trouble

and did so successfully, not by changing the track, but by altering the misplacement of the boiler blowdown water, so that the corrosion which it had been causing was reduced to normal proportions.

Butt-Welding of Rails.—Thirty years ago the civil engineers of the railways in Great Britain were using bull head rails, and they thought that, as these were held in chairs by wooden keys, they would have insufficient lateral stability and would therefore be unsafe if welded into long lengths. Continental experience was with the flat bottomed type of rails and was already extensive twenty-five years ago. In 1933 the German railways had experience with hundreds of thousands of Thermit welded flat bottomed rails. They also had experience with some hundreds of thousands of fully electric flash-butt welded rails, and they willingly shared that experience with all who showed interest in it. They even welded some L.N.E.R. bull head rails experimentally in 1933, and it was at once clear that a new era in the butt-welding of rails had then opened, for the welds were so nearly perfect that they were obviously far superior to any welds previously made in rails. By 1936 the German railway mechanical testing department in Charlottenburg had made many laboratory fatigue tests on their standard flat-bottomed rails. Following up these two lines of research they have gone ahead with confidence, and as a result of their increased programme of butt-welding they now have many hundreds of miles of delightfully smooth running track.

The Belgians and French also took up flash-butt welding of rails seriously, and now have hundreds of miles of continuously welded track. The experiments of the S.N.C.F. were typically logical, and helpful for the many people who may still be heard saying " but I thought that expansion joints were necessary." The French railway scientists tested fishplated rails and also long welded lengths of rails under an increasingly severe longitudinal compressive stress and observed the strain. Such stresses were thought to imitate the compressive load which occurs when a steel rail is subject to intense heating by direct sunlight, as may happen with the main line rails which are fixed up in the air but never happens to tram rails embedded in concrete. The valuable lessons to be learned from these French experiments may best be appreciated by studying the two simple diagrams in Figs. 1 and 2.

In Fig. 1 we see the rails fixed to the

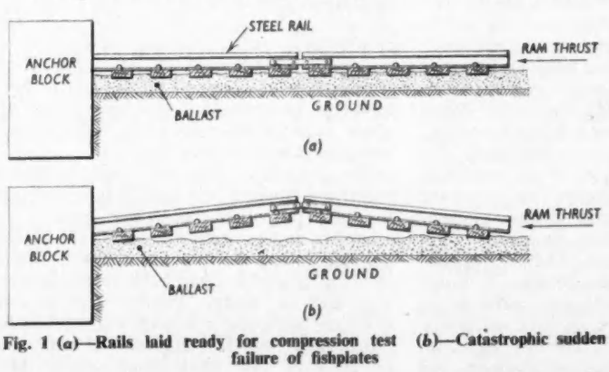


Fig. 1 (a)—Rails laid ready for compression test (b)—Catastrophic sudden failure of fishplates

sleepers and carefully laid on ballast in the usual manner, with a solid earth foundation. If the end compressive stress is sufficient to cause the deformation of the straight rail length, one cannot expect it to bend downwards into the earth. It might move sideways if the ballast did not provide sufficient resistance to the sleepers moving laterally. The rail is much more likely to be pressed up into the air and carrying the sleepers with it breaks their connection with the ballast so that they may now bend easily to either side. As soon as the sleepers are raised the lateral resistance of the ballast is lost, and that may cause a catastrophic deformation of the track. Moreover, after little deformation one may expect the sudden failure of the relatively weak fishplate joint, and the essential continuity of line to be lost.

Now study Fig. 2, in which the increasing

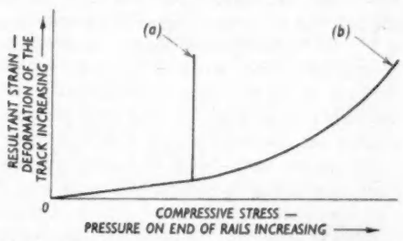


Fig. 2 (a)—Catastrophic sudden failure of fishplated joint in rails (b)—With rails welded in continuous lengths, deformation continues without sudden failure

end thrust stress is plotted against the deformation caused as the rails are strained out of their correct alignment. After a certain intensity of end compressive stress is reached the fishplated rail deforms catastrophically, whereas the continuous length of flash-butt welded rail is strained much further without fracture.

Are Expansion Gaps Necessary ?—In Europe there are now many hundreds of miles of continuously butt-welded rails in the tracks of the main line railways. Where, then, do the longitudinal compressive stresses in summer and tensile stresses in winter go ? Why do these continuously welded rails not buckle in summer and snap in winter ?

One answer to those questions is that it has long been observed that when the longer lengths of rails were made by the rail mills they have not expanded in the track as much as was expected from experience with shorter lengths. Much of the railway engineers' experience during the last century was obtained with what we should now regard as relatively short lengths, but during the last generation the mills were regularly delivering 60ft lengths and one mill delivered a fair amount of 90ft lengths and some 120ft lengths, but the extra cost of these seemed to make them uneconomical. However, they did serve to give experience in the expansion in practice in the track with longer lengths than were the normal.

It seems that frictional restraint of the rail fastenings, chairs or base plates, sleepers and ballast, prevent the expansion which would occur were the rail laid for unimpeded movement on roller bearings. There is thus a residual longitudinal stress, compression in summer and tension in winter, in the metal of the rail. The magnitude of such stresses may be minimised by laying the rails, or slackening off and refastening the rails, in temperate weather when the extremes of heat or cold are absent.

One may picture the sleepers as fulcrums, for the weight of the approaching train presses the rail down and so tries to lever up the rail on the far side of the next sleeper, where the track is not yet weighted down by the train. Increasing the number or weight of the sleepers helps to prevent this tendency for a " bow wave " in front of the train to lever up the sleepers from their essential contact with the ballast.

We are thus faced with the fact that long welded lengths of rails, carefully laid in temperate weather on heavy well-ballasted sleepers, are actually safer than shorter lengths of rails provided with the theoretically necessary expansion gaps. Unfortunately, those gaps may be closed unintentionally by rail creep or by the trapping of a stone.

If one is still worried by the question of where the expansion goes, it is well to recall that, although we measure the free longitudinal expansion of metals when heated in a physics laboratory, any single crystal grain in the steel of a rail will tend to expand in all directions, and if restrained in one direction it may expand more in other directions.

Institute of Metals Spring Meeting

THIS year's spring meeting of the Institute of Metals promises to be of outstanding interest. It commences on Tuesday morning, March 29, with the Annual General Meeting, in Church House, Westminster, during which the new President, Sir Ronald Prain, O.B.E., Hon. M.I.M.M., is to read his presidential address on " Mineral Resources and Metal Reserves." Scientific papers are to be discussed that afternoon and during the mornings and afternoons of the following two days.

On Tuesday evening, in the Hoare Memorial Hall of Church House, Westminster, Professor P. M. S. Blackett, M.A., Hon. D.Sc., Hon. LI.D., F.R.S., is to give the Institute's so-called May lecture, his subject being " The Magnetism of Rocks and Continental Drift," a matter of topical interest because it has recently been found that rocks older than, say, 100 million years are magnetised at angles markedly different from the earth's present field. On Wednesday as an alternative to the scientific paper programme for the afternoon members are invited to be shown round the Victoria and Albert Museum. That evening they are to gather in the Institute's headquarters, at 17, Belgrave Square, London, S.W.1, for a reception, conversazione and exhibition.

On Thursday one of the two simultaneous sessions has been arranged by the Metallurgical Engineering Committee to discuss four papers, the titles of which are :

(1) " Rolling hard materials in thin gauges: basic consideration."

(2) " The rolling of thin Titanium strip."

(3) " Rolling Aluminium foil : an experimental study on a modern mill."

(4) " Some experience in cold rolling thin alloy strip."

These four papers will be of wider interest to engineers than some of the other papers which are to be discussed, some fourteen papers in all.

The Prime Minister (The Rt. Hon. Harold Macmillan, P.C., M.P.) is to be the principal guest at the Annual Dinner of the Institute of Metals at Grosvenor House, Park Lane, London, W.1, where he is to propose the toast of " The Institute of Metals and the Non-Ferrous Metals Industries," on Thursday, March 31, 1960, at the conclusion of the Institute's Spring Meeting.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ROUTINE CALCULATIONS

SIR,—It was remarked in THE ENGINEER recently* that "essential truths sometimes dawn on one only during application to routine calculations." How often does this happen! An algebraic formula may have a striking and useful significance that remains hidden until it has been expressed as a graph perhaps after much labour in arithmetic. We once plotted many points on the curve $y=\sqrt{(9-x^2)}$ before we realised that it could be drawn with a pair of compasses.

The route by which the solution of a problem is reached may happen to have been an unnecessarily tortuous one, but the concentration required to devise it, followed by the relief on eventual success, diverts thought from the possibility of a shorter alternative. If the result is expressible as a simple formula, that suggests that there may be some simple way of proving it, and the relentless seeker for perfection may then be persuaded into a further quest. If the result is a complicated formula, it is natural to express it as a curve or a family of curves or a number of families of curves. This is a job for arithmetic, the engineer's most powerful mathematical tool, applied as repetition work that is tedious except in so far as it may be light relief to the erstwhile tamer of intractable equations.

What happens during the light relief? Does the analytical part of the brain unknown to its owner, re-attack the original problem and, with the answer established, perceive a straighter way to it through the now-circumvented morass? Or does the commonsense department, afflicted with a divine laziness, revolt at a long mechanical task, and contemptuous of a laboured solution of a problem that cannot be really difficult, coolly review the former field of fevered endeavour and discover the wood in spite of the trees, while hand and the menial mental division continue to pour out figures?

We once toiled intermittently for a long time to solve a geometrical problem of some practical importance and when hope of success had vanished decided that there was no useful answer. The thought then arose that complete waste of the effort expended might be avoided by the writing of a detailed explanation why there could be no satisfactory solution. The process of devising and working out a numerical example that should prove the point sufficed to show how to solve the original problem.

The answer to many a difficult question comes suddenly by what is often called inspiration; it is the result of subconsciously gathering together threads abandoned when the fatigue of making them had left the mind temporarily unable to take the next step. Inspiration is an end-product, and not an example of something for nothing. It requires a rest, not necessarily idleness, but perhaps a period when pressure is transferred from the creative faculty to more mechanical ones. The possible future relegation of all repetitive calculations to machinery will leave more time for creative thought but will time alone suffice to produce it? To what extent may a period of acceptably tedious work be necessary to the fruition of mental effort that preceded it? Do seeds of original thought expand more readily in brain-cells activated by heat, vibration, or some more biological disturbance originating in routine work next door?

W. A. TUPLIN

Sheffield,
February 23, 1960.

* "Some High Spots in Thermal Power Generation," by B. Wood, February 12, page 253.

BRITISH STANDARD No. 3117 : 1959

SIR,—We have to point out an error made in your issue for January 22, 1960, which occurs on page 133, third column. In the reference to British Standard No. 3117 —"Wheel Pairs for Locomotives and Rolling Stock," Part 4, the last sentence reading "Comprehensive testing requirements for wheel pairs are specified for use when balancing is specified," should be transferred to the end of Part 5 in the next paragraph.

A. D. SMALLEY,
Technical Officer

British Standards Institution,
2, Park Street,
London, W.1,
February 29, 1960.

Book Reviews

Advanced Mechanics of Fluids. Edited by HUNTER ROUSE. John Wiley and Sons, Inc., New York. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 78s.

DR. ROUSE is Professor of Fluid Mechanics and Director of the Institute of Hydraulic Research at the State University of Iowa, and his eight co-authors are present or past senior members of the research and teaching staff of that University which, as is well known, occupies a leading position in the field of fluid mechanics and hydraulic engineering. The present book is intended to be the advanced companion volume to Rouse's *Elementary Mechanics of Fluids* which was published over a dozen years ago, and is likely to prove as authoritative and helpful a work at the level of the candidate for a doctorate as the earlier book is at the level of the bachelor's and master's degrees. Both books were founded on lecture notes developed over many years, and are designed as text books for formal courses. *Advanced Mechanics of Fluids* will also serve as an effective guide to students of fluid mechanics, especially those with interests in civil, mechanical and chemical engineering, and perhaps in aerodynamics, if they possess a good mathematical apparatus and wish to extend by independent study their already advanced knowledge of the mechanics of fluids. Younger research workers should find it especially stimulating.

The production of the book is excellent. The transition from one chapter to the next gives no indication of any conflict of interests on the part of the authors. There are useful author and subject indexes, and approximately 300 problems and examples (with solutions).

As in his joint book* on the historical development of his science, Rouse again communicates to the reader the feeling that progress in this field has, on the whole, been slow and that our generation—in spite of much fine work—is still faced with a vast region awaiting discovery and exploration. In Chapter I he discusses the roles of mathematical analysis and experiment, dimensional analysis and dimensionless parameters, and touches on the principles underlying a few typical research problems.

Chapter II defines the variables used in the mechanics of fluids, and shows how the axiom of the conservation of mass and Newton's laws of motion lead to the kinematic and dynamic equations of motion. Chapters III and IV deal with classical hydrodynamics: III, on the principles of hydrodynamics, containing useful mathematical instruction and reference to graphical, analogue and "relaxation" methods of solution of certain hydrodynamic equations (curiously, without acknowledgment of the originators of the techniques, and indeed, without reference to the most authoritative publications), and IV, dealing with conformal representation of two-dimensional flow.

The laminar flow of Newtonian fluids is rigorously analysed in the first part of Chapter V, in which the small number of exact solutions of the Navier-Stokes equations is mentioned. The second part contains examples of the various categories of approximate solutions and a discussion of the stability of laminar flow. Again the references are not sufficient for the reader to be able to follow up every idea touched on in the book. This deficiency indicates that the authors are more concerned with helping potential research workers to cultivate an analytical outlook than with summarising the existing body of knowledge for the benefit of a practical user.

The last three chapters—VI, on turbulence; VII, on boundary layers, and VIII, on free-turbulence shear flow (the mixing of streams, jets and wakes)—logically follow from the discussion in the second part of Chapter V on approximate methods of solution of hydrodynamic equations. The authors have indicated how research has been based on often bold simplifications which experience has proved to have been justified.

The student of this book who is also a practising engineer will hope that, in addition to furthering the theoretical training of scientists and research engineers, Dr. Rouse and his colleagues will now make a further effort to bridge the gap between the laboratory and the design office: few men in practice, particularly in civil and mechanical engineering, will feel qualified to apply the contents of this book, even where there patently is a need and an opportunity of such application. Until further papers on the theory and on its practical applicability are written and referred to in the later editions of this work, it will primarily serve the man who is determined to train himself to be a leader and an originator.

* H. Rouse and S. Ince, *History of Hydraulics*, Iowa, 1957.

Annotated Equilibrium Diagrams of Some Aluminium Alloy Systems. By H. W. L. PHILLIPS. The Institute of Metals, 17, Belgrave Square, London, S.W.1. Price 30s.

THIS addition to the Monograph and Report series of the Institute of Metals brings their number up to twenty-five. Within its eighty-six pages the light alloy metallurgical expert will find line diagrams and tabulated data, which would otherwise be hard to find, made easily accessible within a single quarto-sized, cloth-boarded book.

Over the years the Institute of Metals has made available the work of many different authors in this specialised field. Gradually the issue of annotated equilibrium diagrams has grown to number thirty, each of them consisting of the equilibrium diagram of the system, a table of data regarding it, critical notes and references. They are available separately, each having four or six pages. To modern metallurgists the appearance of each of these has been like the naming of constellations in practical astronomy, recalling the production of star-catalogues and the study of lunar topography. The aptness of that analogy is reinforced by recalling that the greatest enthusiast in this work during the last fifty years has been Dr. J. L. Haughton. His bibliography of the constitutional diagrams of the alloys ran to 324 pages in 1956, and when he was a student of metallurgy he spent many night hours at work with the great telescope in the observatory of the University of Birmingham.

It so happens that no less than thirteen of the series of equilibrium diagrams which have been published by the Institute of Metals, have had aluminium as the base. Now in this new book H. W. L. Phillips, who has been for many years associated with the Research Laboratories of the British Aluminium Company, Ltd., Chalfont Park, Gerrards Cross, Bucks, takes the matter much further and gives us annotated equilibrium diagrams of many more aluminium alloy systems.

First he deals with no less than twenty binary systems. These can be depicted easily, each separately on its line diagram. In this manner he shows what occurs when aluminium is alloyed to silver, boron, beryllium, bismuth, cobalt, chromium, copper, iron, magnesium, manganese, sodium, nickel, lead, antimony, silicon, tin, titanium, tungsten, zinc, and zirconium. Then he turns to the known ternary systems, and they are very much more difficult to picture. Although they number only a dozen they require three-quarters of the book. Starting with aluminium-plus-copper he first adds either iron, magnesium, manganese, or silicon. Starting with aluminium-plus-iron he adds either magnesium, manganese, nickel, or silicon. Starting with aluminium-plus-magnesium he adds either silicon or zinc. Finally he depicts the aluminium-manganese-silicon and the aluminium-nickel-silicon systems.

The author has himself been responsible for much work on the constitution of aluminium alloys, but in writing this book he has also searched the literature from far and wide. In each case he has carefully assessed the published literature and selected the most reliable results, which are here recorded for us. The author and the Institute of Metals deserve thanks for this painstaking compilation. It is good to know that such a wealth of research data about the alloys of aluminium is now available in the libraries of the world.

The Physical Metallurgy of Rolling. By F. H. SCOTT. Arthur H. Stockwell, Ltd., Elms Court, Torrs Park, Ilfracombe, N. Devon. Price 10s. 6d.

THIS pocket-sized little book of only ninety-four pages endeavours to stimulate increased observation of, and interest in, the phenomena connected with the intentional deformation of metals during their treatment in rolling mills. The author, who studied in Sheffield University and is a member of the Iron and Steel Institute, approaches rolling as a combination of his own practical experience and theoretical training ; a blend of rolling and physical metallurgy. But his quotation of Henry Cort, as though the rolling of metals dated from him, is surely misleading. It was the use of grooved rolls, which marked the great advance due to the unlucky Mr. Cort in 1783. From much earlier times rods, bars and plates were made by hand or water-powered hammering. Then it seems that in 1728 Major Hanbury introduced the process of sheet iron rolling, which was then described as the " art of expanding bars by compressing cylinders." His mill in South Wales was driven by water power and had plain rolls. Mills for the slitting of iron were known about A.D. 1500 in Belgium and Germany and later in England, where iron was first drawn out between plain rolls and then sheared or clipped into the smaller pieces needed for making nails. An illustration of a rolling mill for lead plates appears in a French book about the manufacture of organs, dated 1624. Hence it would seem that the rolling of metals had been commenced some two centuries earlier than the time suggested. Either less or more should surely have been written about Cort, the better to guide readers.

The seven short chapters of this book are not sufficiently documented for an academic thesis, nor are they clearly enough presented to be readily adapted to the teaching of manual operatives. Sometimes, too, the writing is slipshod, as when in the short bibliography, whose sole purpose should be to save the reader trouble, reference is made to an undated alleged book by U. R. Evans on *Corrosion*. Dr. Ulick R. Evans, F.R.S., produced a famous long classic *Metallic Corrosion, Passivity and Protection* in 1937, revised in 1946. Later in 1948 he published a short *Introduction to Metallic Corrosion*, intended for students. Perhaps the author intended to refer his readers to the latter.

THE ENGINEER Buyers Guide

THE 1960 edition of *The Engineer Buyers Guide* was published on February 26 and one free copy has already been despatched by post to all direct postal subscribers. All regular readers who buy THE ENGINEER through newsagents should also have received one.

This latest edition contains 976 pages, including the " Buyers Guide " section (2650 classified products with 34,750 entries), " Address " section (1850 firms), and lists of U.K. Agents for Foreign Firms, Trade Names, Associations, Institutions and Societies connected with the Engineering Industry, National Undertakings and Forthcoming Engineering and Industrial Exhibitions.

Any subscriber or regular reader who has not yet received a copy should write to the Manager, THE ENGINEER, 28, Essex Street, Strand, London, W.C.2. Additional copies are obtainable at 7s. 6d. each (postage 1s. 9d. extra).

Books of Reference

Rules and Regulations for the Construction and Classification of Steel Ships, 1959. Lloyd's Register of Shipping, Garrett House, Manor Royal, Crawley, Sussex. Price 42s.—The 1959 edition of *Lloyd's Rules and Regulations* follows the general pattern of previous editions with the contents set out in chapters given alphabetical symbols from " A " to " P," and embodies all the additions and amendments adopted by the Committee since the issue of the 1958 edition. The first three chapters deal generally with regulations while the remainder are concerned with construction rules, with Chapter " D " dealing with steel ships, including oil tankers, and including tables of scantlings and equipment and geometrical properties of sections. Other chapters have as subjects pumping and piping, fire-extinguishing arrangements, refrigerated cargo installations and the quality and testing of materials. Steam engines, internal combustion engines, reduction gearing and spare gear for the same are dealt with in Chapters " H " and " K," while " J " gives rules for boilers and pressure vessels.

Two chapters, " L " and " M," are devoted to electrical propelling machinery and electrical equipment and the volume concludes with particulars of the Society's committees and surveying staff.

The Shipping World Year Book and Who's Who, 1960. The Shipping World, Ltd., 1, Arundel Street, London, W.C.2. Price 60s.—This is the seventy-second edition and is set out in five parts which cover the various divisions of the maritime industries. Part IV, in a number of sub-sections, deals with shipowners and managers, shipbuilders, ship repairers, marine engine builders and licensors, tonnage and salvage contractors at home and overseas, and also port and harbour authorities in the United Kingdom. Particulars of government, together with British and international, maritime organisations, are recorded in Part V, and include names of office holders and members of committees. Comprehensive information concerning fleets, capacity, traffic movement, cargo handled, &c., is given in the statistical section, while Part II records information regarding personalities connected with the maritime industries. This section is preceded by a general chapter which includes general information such as weights and measures, bunkering ports, terms and abbreviations and freight units, &c., and the volume concludes with an alphabetical index to firms.

Electricity Undertakings of the World : The Electrical Journal *Red Book*, 1959–60. Edited by Norman H. Codling. Benn Brothers, Ltd., 154, Fleet Street, London, E.C.4. Price 30s.—This is the sixty-ninth edition of a reference book, which aims to give world-wide coverage of the electricity supply industries. Like the previous edition, it is divided into sections dealing with British power stations, the Electricity Council, the Central Electricity Generating Boerd, the Area Electricity Boards, service centres and consultative councils, and other undertakings in the United Kingdom. There are also separate sections on electricity supply in the British Commonwealth and in foreign countries. Most of the changes in this edition relate to undertakings in the British Commonwealth : new entries have been added for West Bengal, Pakistan and South Africa ; Ascension Island and Christmas Island are listed for the first time. Amongst foreign undertakings, New Caledonia Archipelago appears for the first time and there are new entries for Costa Rica and Poland.

Books Received

Cybernetics and Management. By Stafford Beer. The English Universities Press, Ltd., 102, Newgate Street, London, E.C.1. Price 25s.

Beaches and Coasts. By Cuchlaine A. M. King. Edward Arnold (Publishers), Ltd., 41, Maddox Street, London, W.1. Price 65s.

Jahrbuch der Elektrowärme 1958-59. By H. Müller. Vulkan-Verlag Dr. W. Classen. Essen, Western Germany. Price DM.68.

Radio Valve and Television Tube Factory

To show the many uses of gas in the manufacture of television tubes and radio valves the Gas Council and the North Western Gas Board recently organised a visit to the new factories of Mullard, Ltd., in Lancashire. These factories, amongst the largest and most modern of their kind, produce practically every component part of the tubes and valves, and in this article we give a general outline of the layout and main manufacturing processes.

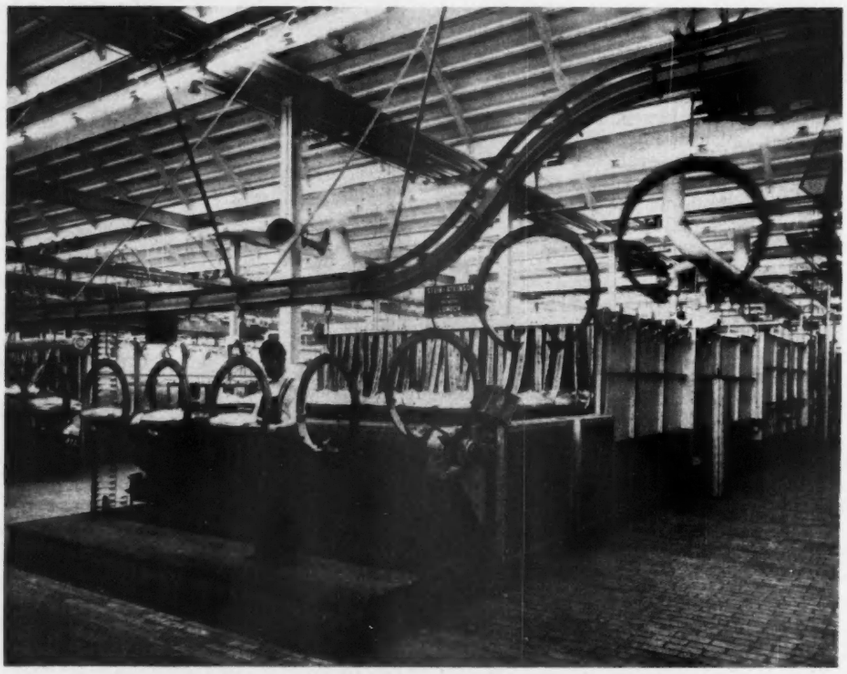
THE use of gas in industry has been steadily increasing for some years, and at the new factories of Mullard, Ltd., in Lancashire, there are to be seen many interesting examples of the way in which full advantage is taken of the characteristics of close control and flexibility of gas as a fuel in manufacturing processes. These factories are engaged in the manufacture of television tubes, valves, glass and fine wire, and between them they use about 1,800,000 therms of town gas a year. In order to show the many ways in which gas is used in these Mullard works, said to be the largest and most modern factories of their kind in the world, a press visit was recently organised by the Gas Council and the North Western Gas Board, which is responsible for the gas supplies.

The first factory visited was that at Simonstone where interest was concentrated on the production of television tubes. For these tubes the initial component parts are the cylindrical neck, the flared tube and the rectangular faceplate. These parts are received from outside sources, and are first examined for accuracy and freedom from blemishes before passing into the lines on which they are assembled. The first operation is the welding of the neck on to the cone on one of six, twelve-station, automatic rotary machines similar to that shown in our illustration. At the successive stations the two parts are first pre-heated by radiant cup gas burners and gas air burners, the final weld being effected by oxy-coal gas jets. In the pre-heating stages a very close heat control has to be exercised on the two parts as the neck is made of lead glass and the cone of quartz glass, which has a much higher melting temperature. The tubes are then transferred to a side sealing machine where the metal e.h.t. connection is fused into the sides of the cones. In this operation the region of the seal is pre-heated by radiant cup burners and gas-air jets, and the final seal is made with the use of oxy-coal gas jets. Subsequently, in order to remove any strains in the glass, the neck and cone assembly is annealed in a continuous oven, which also serves to pre-heat the assembly ready for the faceplate to be joined on. At the same time in an adjoining furnace a complementary faceplate is pre-heated to the same temperature.

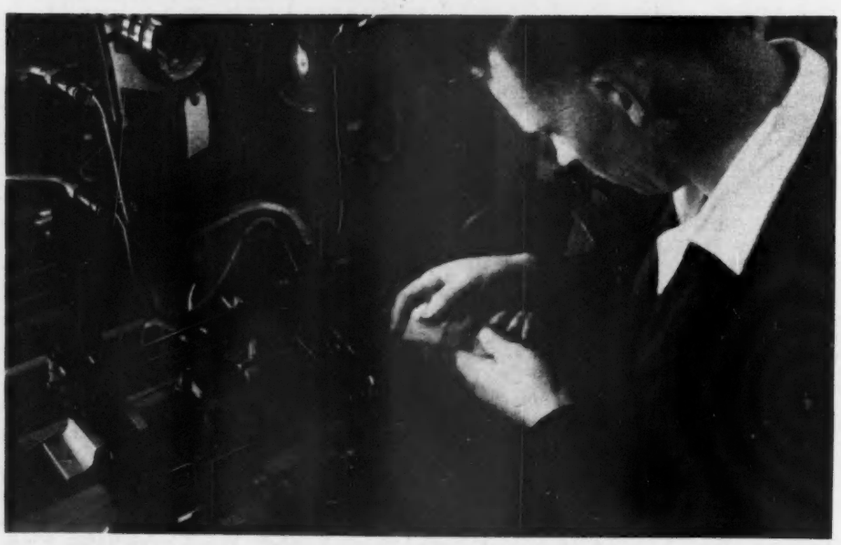
The next operation of welding the faceplate to the cone is carried out on one of twenty-four automatic machines. The faceplate is placed on the rotating table of the machine and the cone, suspended by its neck from the spindle above, rotates at the same speed. The gas jets used in welding are mounted on oscillating carriers, which move in unison with the rectangular profile of the assembly to maintain the burners at a constant distance from the work. Initially the two parts are pre-heated by gas-air jets and their temperature in the welding region is then raised by oxy-coal gas jets. The actual weld is then effected by an electric arc, struck through gas flames, as a small gap between the parts is closed when their melting point is reached. Subsequently, the completed tubes are annealed in gas furnaces to remove any residual stresses.

The tubes are then placed in the specially designed hangers of an overhead conveyor system some 2 miles long, which runs through the entire plant. This conveyor system is set out in thirty sections, and all subsequent processes are planned round it. By arranging journeys of suitable length between processes, the conveyor is used for operations like slow cooling and drying; it can also act as a store between processes, reducing handling costs and the possibility of damage. On it many operations are performed without removing the bulbs or tubes.

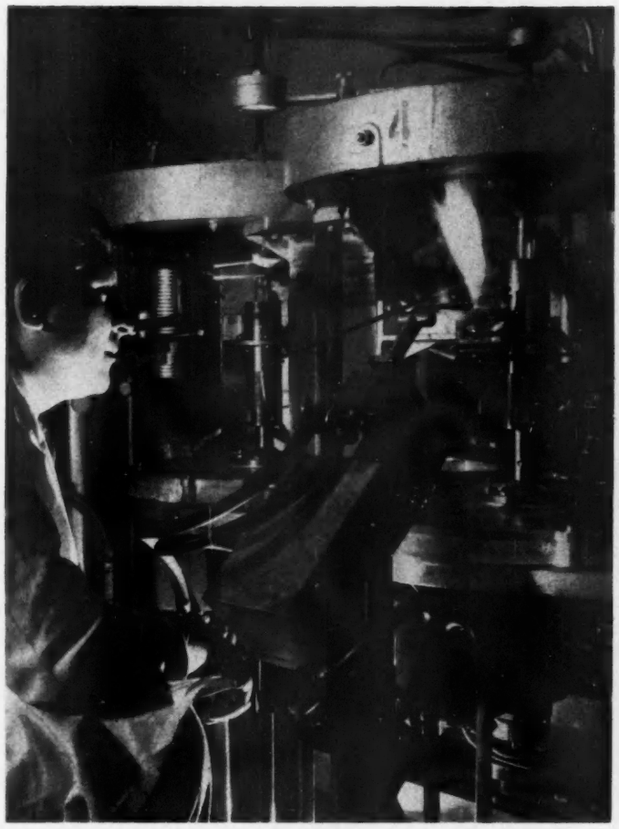
At the start of the next stage in manufacture the cooled bulbs are thoroughly washed with different solutions, finishing with purified water, to prepare them for the process of laying the fluorescent screen in specially designed rotary mills. These mills are fitted with dispensers which automatically deliver into a tube the correct amount of buffer solution, water glass and fluorescent powder.



One of two 100ft-long Lehr furnaces used to bake the fluorescent screen material on to the glass faceplate of a television tube



One of the machines used for welding together the component lengths of the tri-metal connecting wires for radio valves



Automatic machine for joining together the neck and cone of the bulb. The glass parts are pre-heated by radiant cup gas burners, and the weld is made with oxy-coal gas jets

As the tubes travel round the mill the fluorescent powder gradually settles down through the buffer solution evenly on to the surface of the glass, where it is held by a gel-like formation produced from the different solutions. As they complete their circuit round a mill the tubes are automatically tilted to remove the liquid, leaving the screen deposit undisturbed. The tubes are dried in an infra-red lamp unit and with filtered air before being given internal coatings of lacquer and graphite, the latter to form an electrical connection between the final anode and the e.h.t. connector.

The tubes are then ready for laying the film of aluminium on the inside of the screen and cone which acts as a mirror behind the fluorescent screen, and increases the brightness of the picture. This film also prevents the screen being damaged by heavy ions during the tube's working life. This process is carried out on rotary machines, and to form the mirror a small pellet of aluminium attached to a wire filament is inserted in the tube, from which air is then evacuated. The filament is then heated by electric current, and the aluminium pellet evaporates in the vacuum to spread evenly, and microscopically thinly, over the inside surface of the screen and cone.

The tubes are next passed slowly through one of two continuously-operated 100ft long Lehr furnaces to drive off all moisture and to bake out the unwanted constituents of the various coatings, which would otherwise make it impossible to maintain the necessary vacuum in the finished tube. This baking process also fixes the fluorescent screen firmly to the glass face. The Lehr furnaces, one of which we illustrate, are indirectly heated by gas-fired tubes, and are the biggest single gas consuming units in the entire plant. They each have a starting consumption of 6000 cubic feet of gas an hour and an average hourly running load of 4000 cubic feet. The tubes travel through the furnaces on a 12ft wide conveyor belt over a period of 125 minutes. The temperature through the furnaces is zoned automatically at seven points, rising from 20 deg. Cent. through 420 deg. Cent. and back to 25 deg. Cent.

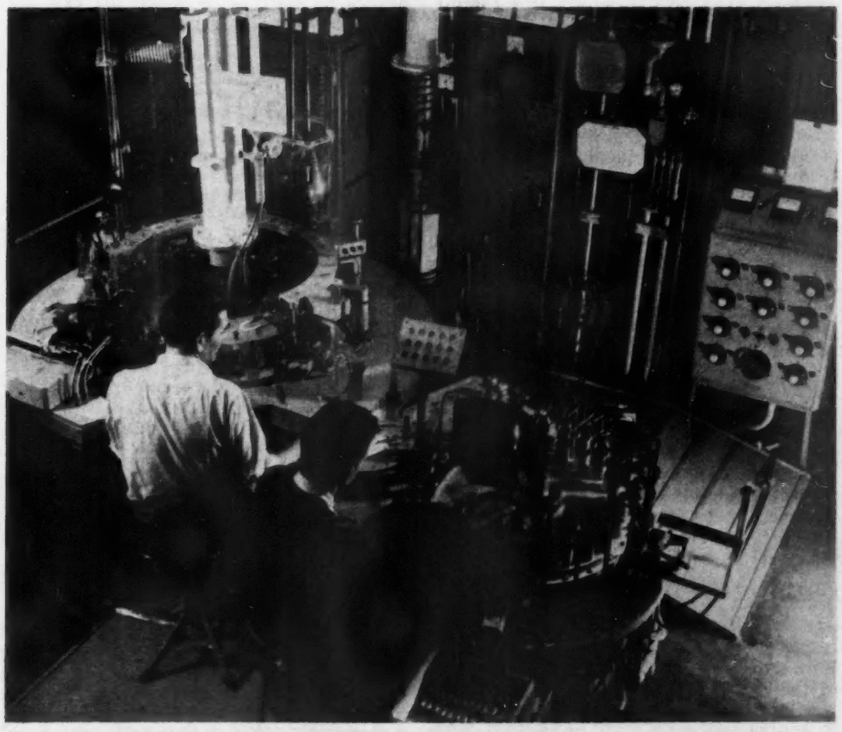
The tubes are then fitted with their electron guns, which are assembled in another part of the factory, in a twelve-station rotary machine, which seals the gun into the neck of the tube. These machines have radiant cup gas burners for pre-heating the region of the join and oxy-coal gas jets for effecting the actual seal. The positioning of the gun in the neck is critical, and coupled with the accurate setting of the machine and the maintenance of correct adjustment of the gas flames, is essential.

The tubes are then transferred to vacuum pumping machines, where air is withdrawn from the bulbs and the internal components degassed to create the necessary very high vacuum. Each tube is mounted on an individual pumping trolley circulating round in the machine and, while the air is being removed, the trolley carries the tube through a long, heated tunnel. This heating serves to drive off any gases present in the metal electrodes, the glass bulb, or the screen materials. At the same time, an electric current is passed through the heater to give the cathode the necessary emissive properties. These operations completed, a " getter " is " fired " by induced high frequency currents. This getter is necessary to trap the last traces of gas remaining in the tube and any which may be released during its working life—so maintaining the required high vacuum. Each tube is then connected to power supplies and its internal metal components are bombarded by electrons from the cathode to stabilise its performance. It is then subjected to a series of rigorous tests under working conditions to ensure high performance and reliability ; at this stage the quality control department selects batches of finished tubes at regular intervals for a comprehensive series of tests.

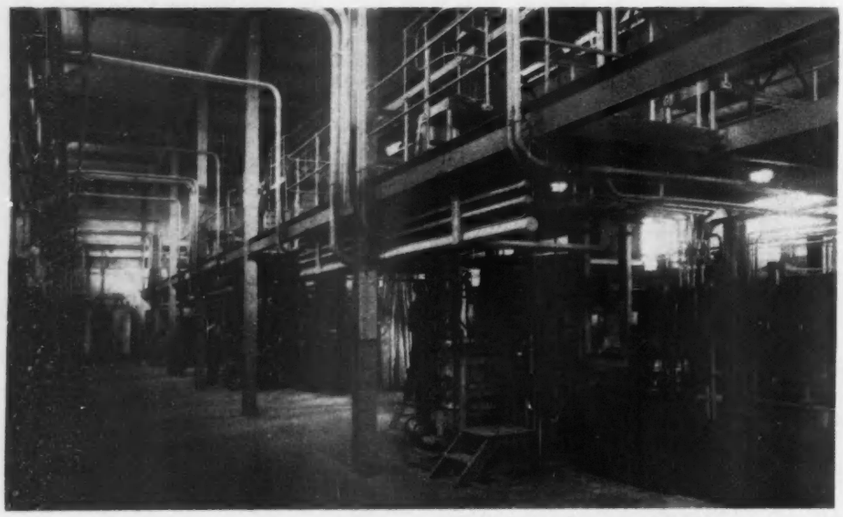
Valve Manufacture

The Blackburn works of Mullard, Ltd., is laid out for the manufacture of receiving valves, chiefly for radio and television purposes, and, apart from mica spacers and the nickel used for some electrodes, all the components are made within the plant. The basic components of a valve are : the electrodes, comprising heater, cathode, anode and, excepting diodes, one or more grids ; the glass envelope and base ; the internal supporting members, mica spacers and insulators. These components are fabricated in separate parts of the plant and brought together in the large assembly bays, where the complete valves are built up.

In the assembly bays the electrodes are assembled into a " cage," ready to be mounted on a base. This base is a small disc of glass holding the connecting pins by which the valve plugs-in to the valve-holder and a corresponding number of wires to which the



Rotary pumping machines for removing the air from valve envelopes to create the necessary vacuum. Gas jets seal the base to the envelope and " pinch-off " the pumping stem when the air has been removed



Glass tube making furnace floor. The glass tubing is drawn vertically upwards from machines at the sides of the furnaces

various electrodes are connected. Joining the stiff metal pins and the thinner connecting wires is a third length of wire which has the same overall coefficient of expansion as the glass, and which therefore ensures a perfect air-tight seal where the wires pass through the glass.

The machines used for making the bases automatically feed the correct number of tri-metal connecting wires into a jig and a collar of glass is placed round the wires. As this assembly is then rotated at various stations round a machine, gas flames soften the glass collar which is gently pressed into shape around the centre sections of the tri-metal wires. Special machines are then used to cut the connecting wires into the right lengths and bend them to the required angles for the electrodes to be welded to them.

The electrode cage joined to the base is transferred to one of the multi-station machines illustrated, where it is sealed into a glass envelope which is evacuated to form the vacuum necessary to the operation of the valve. In this operation gas jets are employed to soften the glass at the junction of the base and the envelope before the sealing machine automatically applies the correct pressure to form the joint. A pumping stem which forms an integral part of the assembly is pinched off once the air has been removed. While air in the valve is being evacuated, the metal components inside are heated by induced high frequency currents to drive out any gases which may have been absorbed during manufacture. A current is passed through the heater to reduce the cathode coating to oxide, thus forming the electron emitting surface, and induced heat is again used to evaporate the " getter " to absorb the last traces of gas.

A large section in the Blackburn plant is given over to the manufacture of tungsten and molybdenum wire, much of which is used for the grids and filaments in the valves produced and a substantial amount of which is supplied to other manufacturing industries for a variety of purposes. This wire, which is made in sizes down to 0·005mm, is made throughout in the factory from the basic materials to the final product. The production departments are equipped with the firm's own designs of machines and all the diamond and tungsten carbide dies are made on the premises.

In the following brief account of wire-making reference is made to tungsten, but the production of molybdenum follows a broadly similar pattern, with variations dictated by the chemical differences in the two ores. First, scheelite ore is ground continuously and the resulting very fine tungsten oxide powder is purified chemically. It is then placed in reducing furnaces where, in a hydrogen atmosphere, it is converted to tungsten metal powder. Controlled amounts of special additives are introduced into the pure powder to control its crystal structure and to prevent the finished wire sagging, and the powder is then compressed into bars of convenient size.

For the subsequent sintering processes, which crystallise the compressed powder into a hard metal ready to be made into wire, the bars are heated in an atmosphere of hydrogen and then have passed through them an electric current of between 2000A and 3000A. The first stage of converting the sintered bars into wire of the required thickness is by swaging, in which the bars are raised to white heat in gas furnaces and then hammered in successive stages until they take the form of thin rods.

The tungsten rods are drawn through a series of progressively smaller dies, first on a chain bench, next on large diameter drums, and finally on smaller drawing heads. Hard metal dies are used in the initial stages, but as the wire becomes thinner, diamond dies are necessary. Gas is used throughout the drawing operations for heating the wire before it is pulled through the dies and also in the annealing furnaces through which the wire passes at predetermined intervals to remove strains. The finest gauge wires are reduced to final size by the etching process.

Some 14,000 miles of lead glass tubing is made each year in the Blackburn factory for use in the valve and television tube sections, and the furnace floor of the glass plant can be seen in one of our illustrations. On this floor the basic ingredients of red lead, sand, sodium and potassium carbonates and other chemicals are mixed and fed by hoppers into the furnace glass melting tanks. The oil-fired furnace of these tanks maintains the glass at a temperature of about 1500 deg. Cent. and from the tanks the liquid glass pours into a gas-heated holding and feeding furnace at the side. From rotating tube-forming machines on these feeding furnaces glass is drawn vertically upwards in a continuous tube. This design of machine has in its centre an inverted cone up through which air is blown at low pressure. Molten glass round the cone is drawn straight up from the centre, forming a tube round the upward jet of air. By adjusting the cone size and the air pressure, the inside diameter of the tubing can be varied to suit particular requirements.

As the newly-formed tubing rises it passes through a circle of air jets which keep it round and control the thickness of the tube wall. These jets are adjustable so that an exact wall thickness can be obtained and maintained throughout production. In a room 25ft above the furnace floor, where machine rolls grip the tubing and draw it up in an endless column, operators cut the tubing into suitable lengths as it rises.

"Consort" Nuclear Research Reactor

A SMALL nuclear research reactor moderated and cooled by ordinary water is to be made and marketed by The General Electric Company, Ltd., of England. It is known as the " Consort " and was designed jointly by the G.E.C.–Simon-Carves Atomic Energy Group, Erith, Kent, and the nuclear power group at The Imperial College of Science and Technology, London University.

Originally the design was developed for the proposed installation to be operated by the nuclear power group of Imperial College, under Professor J. M. Kay, at a convenient site outside London. This proposal, which is part of the College's programme for the expansion of its nuclear engineering training and research facilities, has been approved in principle but at present awaits financial sanction before an order can be placed with G.E.C. The cost of the reactor is about £50,000.

The new reactor was designed to combine some of the main advantages of the two well-known existing kinds of water-moderated research reactors—the " pool " reactor and the " enclosed-tank " reactor. In the former design, the reactor core is housed in a large tank of water at a substantial depth below the surface so that the water itself provides all the shielding needed above the core : this arrangement gives good accessibility and ease of handling of the fuel elements. The enclosed-tank reactor uses a comparatively small tank of water with concrete shielding above the core as well as round the sides ; the whole assembly is more compact than the pool reactor type with the result that it is much easier to locate external experimental assemblies close to the core itself. On the other hand, the fuel-handling system is relatively complex.

" Consort " provides a compromise combining ease of fuel-handling with compactness and good accessibility to the core for experimental facilities. The core is only 10ft below the surface of the water moderator in an open-topped tank, but additional shielding is provided in the form of movable concrete-filled trolleys which cover the top of the tank while the reactor is in operation. There is an experimental " bare face," protected by portable shielding blocks, close to the reactor core. When the reactor is shut down, the shielding trolleys can be withdrawn and manipulation of the fuel elements can then be carried out beneath the water, under direct observation by the operator using simple manual techniques. Furthermore, the whole design is based on the use of a well-proved design of enriched uranium-alloy fuel element which is readily obtainable from the United Kingdom Atomic Energy Authority as a standard production item.

Experimental Facilities.—The new reactor is intended primarily as a source of neutrons for experimental work in research and training. The rating of the original design for continuous operation is 10kW and, at this power level, a flux of about 3×10^{10} thermal neutrons and

2×10^{10} fast neutrons per square centimetre per second is available at an experimental face in the wall of the reactor tank adjacent to the core. A similar flux can also be obtained at the inner face of a graphite thermal column on the opposite side of the tank.

The bare experimental face allows experimental assemblies to be built very close to the reactor core to give a high neutron input. A vertical beam of neutrons can be fed to an experimental assembly (as in water-moderated systems) by means of a dual-purpose thermal column, available as an optional extra. This item consists of a horizontal column of graphite built against the bare face and having a vertical stub at its outer end. By means of suitable voids in the graphite the neutron flux at the end of the stub may be optimised for both strength and distribution. The dual-purpose column may also be used to provide a horizontal beam of neutrons. Other experimental facilities can be provided in the form of one or more beam tubes issuing radially from the reactor tank at core level, while a vertical tube through the centre of the reactor core permits the cycling of specimens into and out of the central flux of 4×10^{11} fast and 2×10^{11} thermal neutrons per square centimetre per second.

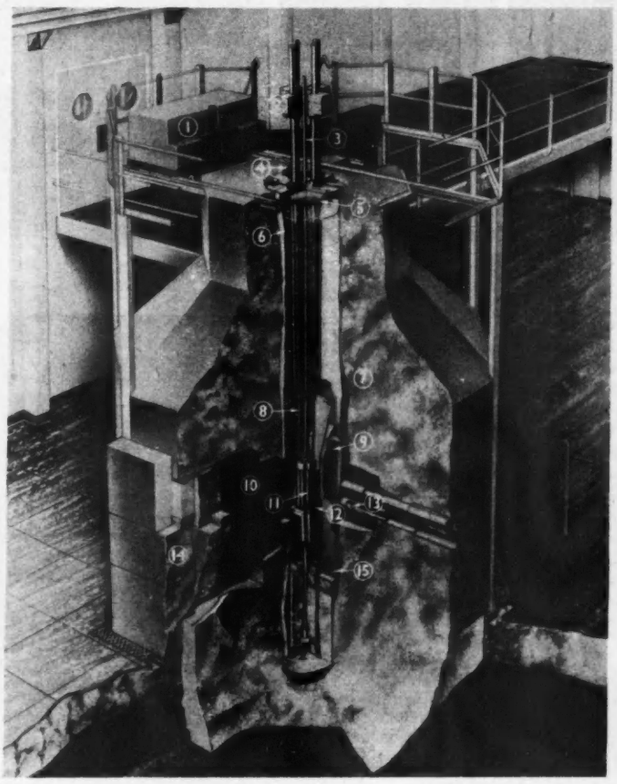
Reactor Core.—The core of the reactor is built up of twenty to twenty-four fuel elements of the standard M.T.R. type, in which the enriched uranium-aluminium-alloy fuel is fabricated in the form of slightly curved plates clad in aluminium. A number of these plates are assembled to form an approximately square-sectioned element with spaces for coolant flow between the faces of adjacent plates. The fuel elements are arranged vertically to form an approximately cylindrical core, each element being located at its lower end by a spigot which engages in a hole in an aluminium support plate. A hole through the spigot permits the water coolant to flow upwards between the fuel plates.

Below the level of the core in the reactor tank, there are shielded fuel-element storage holes, each fitted with a removable stainless-steel shielding plug. These compartments can accommodate a full charge of twenty-four fuel elements. The design of the storage area is such that there is no possibility of inadvertently assembling a critical mass of fuel. The shielding of the holes is adequate to permit direct access to the experimental face and the thermal column one day after the reactor has been shut down.

Reactor Structure.—The accompanying cutaway view shows an artist's impression of the reactor. The core, with its support structure, is mounted near the bottom of a vertical cylindrical tank filled with water to act as moderator, coolant and shield. The tank, which is made of high-purity aluminium, ¼in thick, is open at the top, but a "Perspex" cover keeps the water surface free of dust. Provision is made for the dispersal of hydrogen evolved in the moderator during operation of the reactor and for the detection and collection of fission products in the event of a fuel-element failure.

At core level two rectangular flat surfaces are provided in opposite walls of the tank to accommodate the experimental face and the thermal column. At the same level, the beam tubes project into the tank through tube stubs which are welded to the tank wall and blanked off at their inner ends.

The tank is surrounded by a concrete biological shield, octagonal in plan, with a thickness of about 7ft 6in, reduced to 3ft near the top of the tank. The main body of this shield is a monolithic structure, but on two diametrically opposite faces, removable concrete blocks are used; they give the necessary flexibility in the disposition of shielding around experimental assemblies set up next to the experimental face and the thermal column. This arrangement also provides access to the experimental facilities after the reactor has been shut down. To ensure that such access is not prevented by dangerously high levels of radiation arising from neutron-activation of the concrete, a sheet of cadmium is interposed between the concrete and the tank wall in the vicinity of the experimental facilities. The activation of steel structural members in this area is also reduced by the application of a cadmium coating.



1.—Shielding trolley.
2.—Control rod mechanism.
3.—Vertical experimental tube.
4.—Channel for water connections.
5.—"Perspex" dust cover.
6.—Tank.
7.—Biological shield.
8.—Control rod.
9.—Experimental face.
10.—Thermal column.
11.—Fuel elements.
12.—Core support plate.
13.—Flux-measuring instruments.
14.—Concrete shielding blocks.
15.—Shielding plugs for element storage holes.

Sectioned impression of "Consort," the new British nuclear research reactor designed jointly by the G.E.C.—Simon-Carves Atomic Energy Group and the nuclear power group at the Imperial College of Science and Technology, University of London

Axial shielding above the core consists of a 10ft depth of water which is supplemented, while the reactor is in operation, by a 2ft 6in thickness of concrete. This concrete shielding takes the form of two movable trolleys which run on guides set in the top face of the reactor structure, the joint between the trolleys being stepped and shaped to fit around the control rod support tubes. The trolleys are moved by hand, and interlock limit switches are fitted both at the fully open and at the closed position.

Control and Instrumentation.—The reactor is controlled by vertical neutron-absorbing rods which are of flat section and pass through guide tubes between adjacent fuel elements. There are two shut-down rods, one fine control rod and one safety rod. These four rods are raised and lowered in their guides by driving mechanisms mounted above the reactor.

Two alternative kinds of control-rod mechanisms are available for this reactor. In one design, the upper end of each rod is coupled by an electromagnet to a vertical rack moving between guide rollers. The rack is driven by a squirrel-cage induction motor through a gear-train from which the drive to the magslip rod-position indicator is also taken. In an emergency the electromagnets are automatically de-energised, to release the rods from the racks and allow them to fall into the core under gravity.

In the alternative arrangement, each rod is supported by a stainless-steel wire rope which passes over a pulley vertically above the rod and is then wound round a driving pulley mounted at the edge of the biological shield. This pulley is driven by a small geared motor through an electromagnetic clutch which, under "scram" conditions, is automatically released so that the rod falls into the core.

Instruments for the measurement of flux and other control functions are mounted in shielded holes close to the wall of the reactor tank, the necessary connections being carried in tubes passing through the biological shield. The control equipment and instrumentation for operation of the reactor are housed in panels in a separate control room.

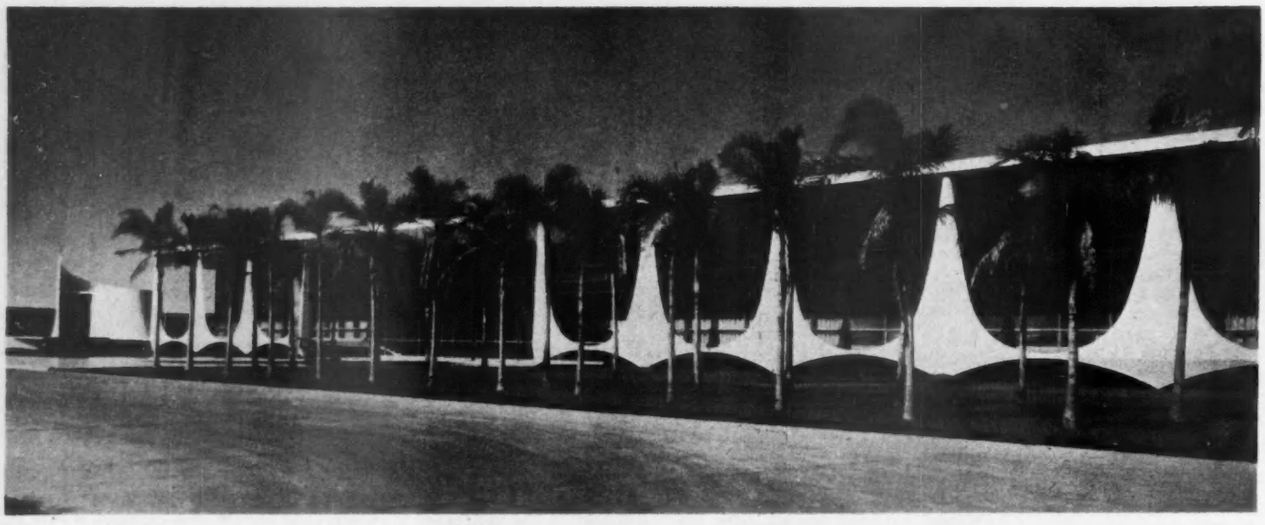
Fuel Handling.—The fuel-handling arrangements are such that, once the reactor has been shut down and the shielding trolleys withdrawn, fuel elements can be transferrred safely between the core and the storage holes by a simple manually controlled operation. The handling tool consists of a long tube with a grab-head at its lower end and release levers at the top. The jaws of the grab are shaped so that an element cannot be released until its weight is fully supported either in one of the storage holes or by the core-support plate. Furthermore, the tool is designed to limit the height to which an element can be raised above the core, thus ensuring that the operator is always shielded from radiation by an adequate depth of water.

Water Circuit.—The water connections to the reactor, comprising inlet, outlet, and overflow pipes, enter the tank through the top. On leaving the reactor, the water is pumped through an external circuit by a motor-driven pump capable of handling 400 gallons per hour. The main circuit includes filters and a cooler which is controlled to stabilise the water-temperature at inlet to the reactor core. The water is maintained at the required purity by continually diverting 10 per cent of the main flow through a water-treatment plant.

All the equipment associated with the water circuit is housed in a plant room adjoining the reactor. A dump tank, installed below ground-level in a shielded pit, is used for holding any active effluents from the water-treatment plant pending their disposal; it can also, in an emergency, accept all the water in the reactor circuit.

Fires in Air Preheaters

BEFORE the Institute of Marine Engineers on February 23, a paper entitled "Corrosion and Fires in Marine Boiler Air Preheaters with Particular Reference to the Ljungstrom Rotary Regenerative Air Heater" was presented by Andrew Bell, B.Sc. The paper points out that the adoption of more advanced steam conditions will lead to a return to the use of gas air heaters, and examines the troubles experienced with such heaters, particularly with fires and corrosion. In the section on fires, the nature and ignition temperature of inflammable deposits, the possible methods of ignition of these deposits, and recommended precautions against fires are discussed. The corrosion section gives an outline of published work on the formation and deposition of sulphuric acid in flue gases as a background to the results obtained over a period of twenty years on twenty-four ships fitted with rotary regenerative air heaters. Results are given for maximum temperatures at which severe corrosion has been found.

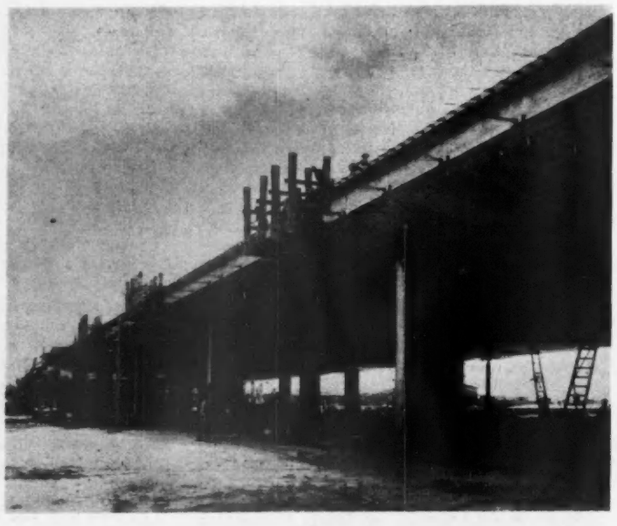


Brasilia

The new capital of Brazil which has been under construction at a virgin site in the interior of the country for the past five years is to be opened in April, when the Brazilian civil service will be transferred to the new ministerial buildings there. The illustrations ABOVE and RIGHT show the presidential palace at Brasilia, designed by Niemeyer. The columns carrying the canopy are described as "swan" columns, and they are of reinforced concrete, clad with marble. The small circular building is a chapel. The break in the facade in the upper view is the main entrance; the free-standing column in the right-hand view carries inscriptions.

Brasilia is planned as a major city, the influence of which, it is expected, will help to open up the interior of the country. The city plan is centred around two main axes, each a broad avenue, one straight and one curved, and forming together a shape like that of a cross-bow. A lake which is something like V-shaped encloses the "bow," with its apex more or less on the straight

axis. The presidential palace is beside the lake close to this apex, and slightly apart from the main body of the city. At the tip of the straight avenue is a twin-towered building forming architecturally a terminal accent. The Esplanada dos Ministerio's—blocks of ministerial buildings and a cathedral—then extends down the avenue to the central junction of the two main avenues. This is naturally a focal point, and is elaborately conceived, with the two roads at different levels, and with pedestrian areas and ramps to the Senate and Congress houses nearby. The prestressed concrete bridge shown under construction RIGHT carries the curved avenue over the formal processional way at this point, but this is only one structure in the complex. The curved avenue is flanked by large squares, each laid out with a number of blocks of flats. In the illustration ABOVE, three such squares are shown in the foreground, next to the avenue, with further squares behind. Entertainment, shopping, and commercial centres will be grouped around the focal junction, but the plan also includes housing estates sited on peninsulas jutting into the lake. A municipal centre will stand at the outer end of the processional way.



SHORTER REPORTS

Applications of Microwaves

A LECTURE on applications of microwaves was given to the Electronics and Communication Section of the Institution of Electrical Engineers on February 24 by Professor A. L. Cullen. He described the subject as one of quite respectable antiquity. Much microwave work was done before 1900, and as early as 1896 Marconi had demonstrated that communication was possible on a wavelength of 30cm, and had also investigated tropospheric scatter in 1930. Early in that decade a 17cm cross-channel link was used. The year 1936 brought a renaissance of microwave work, leading to the intensive activity of the war years, of which the highlight was the invention of the pulsed high-power cavity magnetron. One of the first major triumphs of microwaves in pure science was the determination of the velocity of light, at first to an accuracy of three parts in 10^5 and later improved to three parts in 10^6. These studies gave a result 16 km per second higher than the previously accepted average. In communications engineering, microwave links over line-of-sight paths enabled directional aerials of reasonable size to be used, with high-gain characteristics which permitted low transmitter powers. To cover greater distances, tropospheric scatter systems gave over-horizon ranges of about 400 miles with transmitting and receiving aerials "looking at" a "common volume" in the troposphere. Noise and fading effects could be troublesome, and parametric amplifiers might have great importance in this method of transmission. Ranges might be increased to 1000 miles by using artificial satellites as passive repeaters, and there had been a proposal in the U.S.A. for a helicopter-borne amplifying repeater supplied with power through a microwave beam from the ground.

Among general engineering applications of microwaves, Professor Cullen mentioned the use of 10kW c.w. magnetrons for rock drilling. The wavelength was about 10cm, and the heat produced differential expansion, resulting in cracking of the rock. Diathermy methods were used also in drying timber and curing rubber. He referred also to the growing application in the U.S.A. of microwave cooking, which now had its allotted frequency of 2450 Mc/s and for the most part employed magnetrons of the order of 2kW. Other subjects dealt with in this general survey of microwave practice included radar, electron accelerators, small-scale microwave models for aerial design, and large-scale models for the demonstration of optical and X-ray phenomena.

Chartered Engineers

THE wider aspects of the professional work and responsibilities of chartered engineers provided the main theme of Sir Willis Jackson's speech when he presided at the annual dinner of the Institution of Electrical Engineers in London on February 25. He suggested that the engineering profession as a whole would benefit greatly if the members of the main branches of the profession could be brought closer together under the common title of "Chartered Engineer."

Sir Willis said: "We Chartered Engineers can no longer be merely the creators and controllers of new forms of engineering equipment in all their technical complexity—the very impact of this creative effort is involving us directly in the complexity of human problems we have helped to generate. Does the general public—even the better informed part of it—yet see the engineering profession in the light of its achievements and responsibilities? There are times when I find myself obliged to doubt it . . . It is worth considering whether the cause, and therefore the solution, does not lie mainly within ourselves and, to quite a large extent, in the inability of the general public to distinguish between the many categories of men who carry the description of engineer and, indeed, of professional engineer. In this connection I believe that we have been making an important step forward during recent years by establishing closer collaboration between the Institutions of Civil, Mechanical and Electrical Engineers, and between these Institutions collectively and other bodies . . . .

"There can be no doubt that these exercises in collaboration between existing bodies have helped to restrain the creation of still further specialist organisations, and I think it of the greatest importance on scientific and technological, as well as other, grounds that these forms of collaboration should be strengthened and extended as rapidly as possible. But even if this occurs, as I hope and believe it will, I frankly doubt whether by itself it will be sufficient.

"I therefore want to hazard the view that we shall bring great benefit to the engineering profession as a whole and contribute greatly to the growth of an appreciation of it in the public mind more in keeping with the importance of its national service and potentialities, if we can devise a means of bringing the members of the primary constituent branches of the profession together under the common title which I have used several times this evening—that of the Chartered Engineer.

"I should at once make it clear that by this I do not mean amalgamation, and for the simple reason that I think it essential not to restrain, or even appear to restrain, the vitality and initiative of the constituent branches. Nor do I wish to see the creation of a superstructure of administrative machinery. What I hope for is the minimal device which will ensure that Chartered Civil, Chartered Mechanical, Chartered Electrical and Chartered Chemical Engineers, in the first instance, are seen publicly to be members of an integrated corporate body of Chartered Engineers.

"I do not suggest that a means of doing this will be easy to find even if we all wished to find it—and there may well be many who would not agree with this objective . . . which I know is also in the minds of several other senior members of the engineering profession."

Gas in Industry Exhibition

THE second "Gas at Work in Industry Exhibition" sponsored by the twelve area gas boards and held at the Royal Horticultural Hall, Westminster, will be open daily until Saturday, March 12. This is a particularly compact exhibition, designed to show by way of working plant, models and illustrations, the many and varied uses of gas in all branches of modern industry, from food preparation to electric lamp manufacture, hardening, heat treatment, metal spraying and all forms of heating.

The plant of engineering interest shown in operation includes a fully automatic spin hardening machine for gears made by Surfard, Ltd., 15, Wilton Road, London, S.W.1. In this machine, available for hardening gears up to 5ft diameter and 10in wide, the complete cycle of operations is preset to enable the rapid hardening of a gear to a predetermined depth below the roots of the teeth.

The Incandescent Heat Company, Ltd., of Smethwick, is showing a small continuous furnace fired by the recently developed "Jetubes" high recirculation radiant tubes. A gas and air mixture is burned in a refractory-lined section of the tube and the products of combustion leave this chamber, through a nozzle, at high velocity; in so doing, they entrain the hot gases already recirculating in the body of the tube and so build up recirculation. The system is claimed to give even heating throughout the whole tube, high heat transfer rates and a flexibility of operation. The furnace to be displayed can work at temperatures between 550 deg. and 830 deg. Cent.

A gas-fired equipment consisting of conveyorised preheat and curing ovens for plastic-coated wire ware and metal goods displayed by F. J. Ballard and Co., Ltd., Tividale, Tipton, Staffs, is based upon the utilisation of standard oven sections possessing a high degree of thermal efficiency coupled with low fuel requirements, and a wide degree of flexibility in application. The preheat oven utilises a natural heat seal, while the curing oven is in the more usual tunnel form and comprises two unit-oven sections equipped with standard heat seal vestibules.

A "Mastertherm" continuous core oven is one of four pieces of equipment shown by Radiant-Heating, Ltd., Barnsbury Park, London, N.1. The oven is designed to replace the traditional core stove in mechanised or semi-mechanised foundries. It is stated to reduce drying times by up to 50 per cent and gas consumption by 30 per cent, and is semi-portable.

A gas-fired continuous wire mesh conveyor muffle furnace, used in connection with the annealing and heat treatment of small pressings and similar components, as well as brazing and sintering, is displayed by Dawson and Mason, Ltd., of Levenshulme, Manchester, 19. The furnace is primarily intended for heat treatment in a prepared atmosphere and is capable of an output of 80 lb per hour at a temperature of 800 deg. Cent. The maximum gas burner capacity is 400 cubic feet per hour and this is capable of raising the furnace from cold to the operating temperature in one and a quarter hours.

Air Auxiliaries on P.S.V.s

THERE has been patented by Leyland Motors, Ltd., and Mr. W. M. Little, Transport Manager of Edinburgh Corporation Transport Department, a system of control of the transmission, brakes and door gear of a bus that both simplifies the driver's task and improves the safety of operation. Originally, it involved adding an additional position to the transmission selector gate in which the transmission is neutral and the doors are open (this system has been in use on fifty "Tiger Cub" single-decker buses with "Pneumo-Cyclic" semi-automatic transmissions for nearly a year, with over 1200 door operations a day) but it was possible for the driver to select neutral and open objectionably far from a stop, in order, say, to have a better view of the kerb. There has now been added an air motor which at the same time as the doors open applies the rear brakes; this device is completely additional to the existing foot and hand brakes, which are used when it is not intended to pick up or set down passengers. Since Leyland vehicles have the brake pedal on the right of the steering column, starts on an adverse grade must be made with one of the hand-controlled brakes, and therefore that slaved to the transmission control is supplied through a restrictor so that it relaxes only slowly.

Study Tour of U.S. Roads

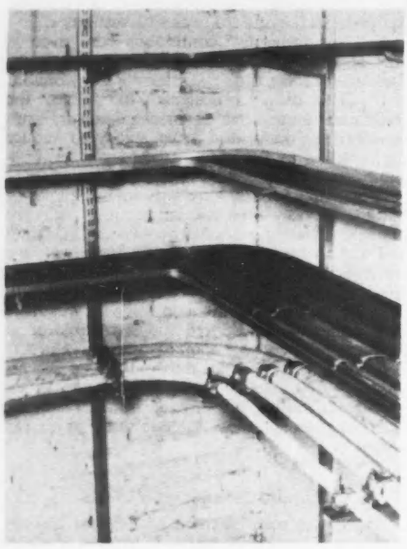
THE Cement and Concrete Association's pavings development group has organised a study tour in the United States from April 24 to May 7. The idea is to study traffic problems generally, and to inspect the road tests now being undertaken by the American Association of State Highway officials. Parking garages, urban motorways and other road systems in cities, and important routes between towns will all be seen, the centres to be visited being New York, Chicago, Los Angeles and San Francisco.

SHORTER REPORTS *(Continued)*

Cable Racking System

MODIFICATIONS and additions to the components of the "Spur" adjustable shelving system form the basis of the "Spur" cable racking system introduced by Savage and Parsons, Ltd., Watford, Herts. Basically the system consists of wall-mounted uprights of mild steel channel with slots at regular intervals in the face, into which fit cantilever brackets ranging in size from 5in to 18½in. To make an "island" site, double-sided uprights can be formed by bolting two slotted channels together and fixing at floor and ceiling with heavy-duty sockets.

Standard cable trays may be bolted to the brackets, or a "Spur" top plate may be bolted on, to which standard cable clamps or cleats



Cable trays and clamps carried by a modified adjustable shelving system

can be fitted. The accompanying illustration shows three levels of cable trays and one of cable clamps in a wall-mounting installation. Safe loads for a bracket range from 280 lb for the 5in size to 160 lb for the 18½in, but considerably greater loads can be carried by using a supporting strut, one end of which engages with the slotted upright while the other end is bolted to the bracket. The system will carry all types of cable up to the heaviest grades generally used in industry and power distribution.

The racking has been devised for simplicity of installation and subsequent extension if required. Prefabrication and detailed installation drawing work are unnecessary, and concrete inserts are not needed, so that when a building is in course of construction the *in situ* concreting and shuttering work is simplified.

[Reply Card No. E3961]

Fuel Pipelines to London Airport

To help to meet the increasing demand for aviation turbine fuels, two 6in diameter pipelines have been laid from the Shell-Mex and B.P. depot at Walton to the company's storage units at the airport, and came into operation this month. Hitherto supplies have been delivered by road tankers, some of 4000 gallons capacity, from storages at Purfleet and Shell Haven, a daily average of forty vehicles being employed, rising to sixty a day during the peak holiday periods, for the round trip of 80 to 100 miles. The new pipelines will pump fuel at a rate of 30,000 gallons per hour and ensure adequate supplies whatever weather and traffic conditions obtain. Initially supplies of turbine fuel will be delivered to the Walton depot from the Shell-Mex and B.P. installation at Hamble on Southampton Water. However, it is planned to pipe supplies from the Kent refinery using the 65 mile Government pipeline built during the war. This pipeline, which runs south of London from the Isle of Grain to Walton, and for which rent will be paid to the Government, is being repaired ready for its new service.

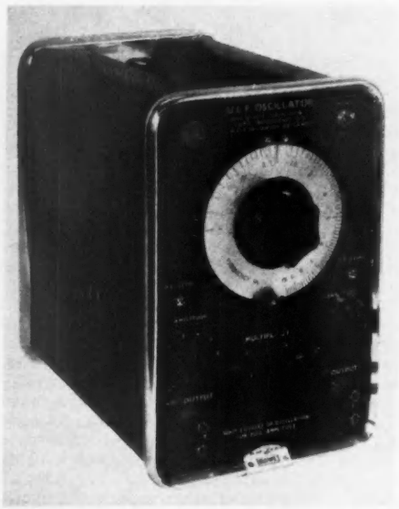
The new twin pipelines follow a line running north-west from the Walton depot and after 6½ miles enter the airport perimeter at its southern corner. Here they branch into two main pipelines and a spur line. The former continue 2¼ miles across No. 5 runway to the 1,000,000 gallons storage depot at Perry Oaks, the company's main storage point on the airport's western perimeter. From here the fuel is pumped under two main runways to the central area depot from which it is delivered by fuelling vehicles to the aircraft on the apron. The spur line follows the perimeter in a north-easterly direction to the maintenance area depot to provide supplies for aircraft undergoing maintenance. Control of pumping will be initially by a telephone system linking Walton, Perry Oaks and the depots, but later remotely controlled automatic pumps will be installed.

The pipelines from Walton, which is south of the Thames, cross the river at Rivermead Island and run north through Sunbury and across Kempton racecourse. Along the route to the airport the pipes crossed seventeen roads and another ten roads within the airport. Thrust boring was used to take the pipelines under a road and under two sets of railway tracks, and at most road crossings the pipes were encased in concrete sleeves. Existing sleeves were used to take the pipelines under the Duke of Northumberland and Longford rivers at the point of entry into the airport. Within the latter the section of pipeline crossing the runway was encased in concrete sleeves placed at a depth of 12ft. To combat the possibility of corrosive attack the pipes were given a hot protective coating, supplied by Wailes Dove Bitumastic, Ltd., reinforced with an inner and outer wrapping of glass fibre. In addition, cathodic protection is being installed. The main contractor was William Press and Sons, Ltd., and K. A. Spence and Partners were responsible for wrapping inspection, while Inspection Services, Ltd., inspected the welds.

U.L.F. Oscillator

CONTROLLED positive feedback through a diode limiter is used in the ultra low-frequency oscillator illustrated to provide rapid amplitude control over the whole range from 0·01 c/s to 1 kc/s. It is stated by the maker, Dawe Instruments, Ltd., 99, Uxbridge Road, London, W.5, that after a sudden transient, as, for example, when changing ranges, the amplitude of oscillation is stabilised within about 3 cycles at all frequencies. The amplifier, which has resistance-capacitance tuning, consists of a phase inverter followed by two integrating stages and is made selective by overall negative feedback. Suitable applications of the instrument are investigations of vibration and strain in machines and structures, or the checking of low-frequency recorders. It may also be used for checking the response characteristics of low-frequency amplifiers used in geophysical and electro-medical research.

At the frequency of oscillation, each integrator gives a phase shift of nearly 90 deg. A quadrature output is therefore available after the first integrator stage which may be used in testing servo systems. The instrument is a further development of a circuit design originated by the Royal Radar Establishment. As in the original design, particular attention has been paid to ventilation to ensure good thermal stability. Air enters through a duct in the base of the cabinet and passes through the specially



Resistance-capacitance oscillator for frequencies from 1 kc/s to 0·01 c/s

constructed chassis wall, so cooling the components on the way up to the exit louvre at the top of the instrument. The oscillator is portable, having overall dimensions of 8½in by 13in by 12½in high, with a net weight of 19½ lb. Power consumption is about 50W from 110V or 200V–250V mains.

[Reply Card No. E3963]

Silicon Controlled Rectifiers

FIVE silicon controlled rectifiers with maximum continuous peak inverse voltage ratings from 25V to 200V comprise the SCR96 series now in production by the Semiconductor Division of The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. The series has been chiefly designed for use in power control and power switching applications requiring blocking voltages up to 200V and load currents up to 10A. Series and parallel circuits may be used for higher power applications.

The controlled rectifier reverse characteristic is similar to that of a normal silicon rectifier, representing essentially an open circuit with negative anode-to-cathode voltage. The forward characteristic will block positive anode-to-cathode voltage below a critical breakover voltage if no signal is applied to the gate terminal, but by exceeding the forward breakover voltage, or by applying an appropriate gate signal, the device will switch rapidly to a conducting state and present the typically low forward voltage drop of a single junction silicon rectifier. A typical gate current to fire the rectifier is 20mA at +1·5V (gate-to-cathode voltage), and turn-on and turn-off times are typically 2 microsec and 15 microsec respectively. The device can be used in inverter circuits and for controlling high-speed circuit breakers.

[Reply Card No. E3964]

Journal Reviewing Construction in Steel

THE first issue of a quarterly journal called *Building with Steel* has been published by the British Constructional Steelwork Association. Its aim is to convey information, both technical and non-technical, about the activities of the structural steelwork industry. Except for an article on the composite construction in progress at Imperial College, the first issue is largely in the latter category, and contains pictorial reviews of recent achievements in structural steel.

Turbo-Electric Propulsion Machinery for the "Canberra"

THE twin-screw turbo-electric propelling machinery for the liner "Canberra" was made in the Rugby Works of Associated Electrical Industries (Rugby), Ltd., the management company of the A.E.I. Heavy Plant Division, which is handling the contract. The machinery is designed for 68,000 s.h.p. at 136·5 propeller revolutions per minute normal service, and 85,000 s.h.p. at 147 propeller revolutions per minute, maximum continuous. Two propulsion turbo-alternator sets normally power independently two double-unit propeller motors.

Excitation requirements for both alternators and propeller motors are met by two of the four propulsion exciters that are available, one driven in tandem with each of four auxiliary 1500kW turbo-alternators.

The switchgear is designed to enable either of the two double-unit propeller motors, or individual units, to be connected to either propulsion turbo-alternator, as service conditions may demand. Similarly there is complete flexibility in the choice of excitation source for either propulsion alternator or motor, or motor half-unit.

Provision is made for synchronising the port and starboard propellers, in any pre-determined blade relationship, should this be found to improve further smooth running in service.

With each alternator independently supplying its associated propeller motor at 85,000 s.h.p. on two screws, the alternator rating is 32,200kVA (C.M.R.), 3087 r.p.m., three-phase, 1·0 p.f., 6000V. With one alternator supplying both propeller motors at 40,000 s.h.p. maximum the rating is 30,700kVA, 2400 r.p.m., 1·0 p.f. 4670V. The steam conditions at the turbine inlet are 700 lb per square inch gauge, 950 deg. Fah.; vacuum, 28½in at 68,000 s.h.p.

The propeller motors are rated at 42,500 s.h.p. (M.C.R.), double-unit, forty-two-pole, 147 r.p.m., 6000V, three-phase, 51·5 c/s, 1·0 p.f.

The propulsion main exciters are rated at 300kW normal, 300V d.c., 1000A, 1200 r.p.m.

Propulsion Equipment.—Each uni-directional single-cylinder turbine has seventeen stages with cam-operated multi-valve control and twin governors. The first governor holds the turbine speed at 25 per cent full speed during synchronisation of the propeller motor; the second is adjustable from 85 per cent full speed to above the maximum service speed, when it is available as a pre-emergency governor. An emergency governor trips at 10 per cent overspeed. Electrically-operated barring gear is fitted.

Each alternator has a non-salient pole rotor and is connected to the turbine by a bellows-type coupling. Cooling air is circulated by ventilating fans carried on the end flanges bolted to the rotor winding retaining rings and sea-water is used as the secondary coolant. The sea-water circulated-air coolers are mounted in a chamber below the stator frame.

The propeller motors are of double-unit construction: each motor consists of two machines, completely separate electrically, built into one casing. They are synchronous machines having a salient-pole rotor with squirrel-cage winding in the pole shoes for induction starting and reversing. Each machine has a closed air circuit with electrically-driven ventilating fans and sea-water circulated-air coolers mounted on top of the stator frame (as illustrated on Plate 7, THE ENGINEER, January 8, 1960).

Each of the four main exciters has a closed air circuit, excluding the commutator only, with sea-water circulated-air cooler mounted in the baseplate. The commutators are of Pollock construction, that is, the copper segments are supported along their entire length, instead of only at their ends as in the conventional commutator.

Propulsion Control Gear and Switchgear.—Port and starboard propulsion circuit set-up switches and reversing contactors are contained in cubicles forward of their respective alternators. Amidships is the excitation cubicle containing both port and starboard excitation set-up switches and contactors. Above it, on the turbine platform, is the control console comprising lever gear and instrument panel.

Both port and starboard drives have automatic excitation control using a "Magnestat" regulator which has no moving parts and adjusts the excitation to suit the ship's speed. Each drive has also a standby "Magnestat" and a hand regulator, with automatic changeover.

The usual instrumentation, and indication and protection circuits, are provided. In addition, an instrument driven by a differential selsyn is fitted to show the relative blade positions of port and starboard screws. Mechanical interlocking prevents incorrect operation of the propulsion levers, and allows access to the control cubicles only when the lever gear is locked in the "off" position.

The lever gear comprises: port and starboard direction levers controlling the reversing contactors; port and starboard starting levers controlling the excitation circuits; and port and starboard speed levers mechanically connected to the turbine controls.

Operation.—For powers up to 85,000 s.h.p., the port double-unit propeller motor is connected to the port turbo-alternator, and the starboard double-unit propeller motor to the starboard turbo-alternator. For powers up to 40,000 s.h.p., both propeller motors can be connected to either turbo-alternator, for greater economy. The full ahead power is available astern for rapid manœuvring in an emergency.

Synchronisation of the two propellers is obtained by switching the two forward half-motor units to one alternator, and the two aft half-units to the other.

At and above 85 per cent full speed, governor control can be introduced if required by the service conditions.

1500kW Auxiliary Turbo-Alternator Sets.—A.E.I. Heavy Plant Division is also supplying the auxiliary turbo-alternators and the air conditioning turbo-compressor units. The four geared pass-out turbo-alternator sets, each with combined condenser, are individually rated 1500kW, 440V, three-phase, 60 c/s, 6000/1200 r.p.m. Steam conditions at the turbine inlet are 700 lb per square inch gauge, 930 deg. Fah. The pass-out pressure is 70 lb per square inch gauge, quantity 15,000 lb per hour.

The alternator has a closed air circuit with two sea-water circulated-air coolers. Voltage control is by a "Magnestat" automatic voltage regulator. The 300kW normal propulsion main exciter is tandem driven from the alternator. Exciters for the auxiliary alternator and propulsion main exciter are vee-rope driven from the propulsion main exciter.

Turbo - Compressor Sets.—Four $5{\cdot}5 \times 10^6$ B.Th.U. per hour, 5150 r.p.m. direct-coupled turbo-compressor units are being supplied for the air conditioning plant; the refrigerant handled by the compressor is "Freon 11." The single-stage turbine has a two-row wheel. Steam conditions at the turbine inlet are 700 lb per square inch gauge, 900 deg. Fah. The turbine back pressure is 25 lb per square inch gauge. The compressor is a two-stage centrifugal machine.

The liner "Canberra" is being built by Harland and Wolff, Ltd., for the P. and O. Steam Navigation Company, Ltd.

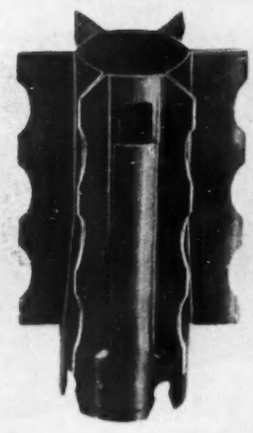
[Reply Card No. E3971]

Heat-Dissipating Valve Shields

STUDIES of the factors influencing the life and reliability of electronic valves have shown the importance of reducing bulb temperatures without otherwise altering their operating conditions. Some of the older types of shield designed for retaining valves in their sockets and screening them electrically actually impair life and performance by raising the bulb temperature. The problem of designing, for mass production, a valve shield that adequately retains and effectively shields a valve, as well as acting as an efficient dissipator of heat, is not a simple one, but these requirements have now been met in a design by a member of the United Kingdom Atomic Energy Authority's staff at Aldermaston, and pre-production prototypes have been made.

The U.K.A.E.A. has granted a licence for the use of this invention to Casemakers, Ltd., Soho Hill, Birmingham, 19, and we illustrate a shield made by this firm in accordance therewith. The shield, known as the "Casco," is made from phosphor bronze, and consists of an annular finned screen designed to fit closely around the valve. The screen and fins are formed together from planished strip, bent and folded to the requisite shape for flexibility in meeting valve tolerances. The fins of the smaller diameter shields are serrated as illustrated to increase their flexibility. Tangs are also provided in the screen wall for valve retention.

The screen is rigidly mounted on a phosphor bronze skirt by supporting fingers which form



Finned valve shield to combine electrical screening with heat dissipation

an integral part of the skirt. The longer fingers are placed to conduct heat away from the valve hot spot to the heat sink. The skirt, which is formed from tubular section, trimmed, pierced and cropped, is dimensioned to fit standard valve holders and permit close spacing of valves, as fins of adjoining screens may be interleaved. The valve shield is protected by a special black finish for maximum heat dissipation.

Tests on prototypes are stated by the U.K.A.E.A. to have shown that under all conditions they are more efficient than other types currently available commercially, either in this country or the U.S.A. Initial tests indicate that they are capable of reducing valve bulb temperatures under certain conditions by some 90 deg. Cent. below the level at which the valves operate without cans, and show an improvement of about 30-40 deg. Cent. over the best type of can so far available commercially. As well as being useful in electronic apparatus for scientific and defence purposes, the shields are also suitable for use in domestic radio and television receivers. Sample shields in two sizes each to cover B7G and B9A valves will be available from the maker this month.

[Reply Card No. E3972]

Surface Treatment for Concrete Formwork

THE construction of precast concrete piles, averaging 65ft in length, for the Avonmouth Docks improvement scheme, which is being undertaken by John Laing and Son, Ltd., includes the use of a new synthetic resinous agent for the surface hardening of timber shuttering. About 1000 precast piles will ultimately be required for this project, which was begun on January 1, 1960, and is due for completion in 3½ years. This newly developed hardener is a liquid known as "Moldcote"; it imparts a smooth impermeable glossy finish which enables a considerably increased number of uses of the formwork and gives an even concrete surface texture. "Moldcote" is being supplied for the project by Stuart B. Dickens, Ltd.

[Reply Card No. E3973]

SHORTER REPORTS *(Continued)*

Small Batch Barrelling Machine

A RANGE of self-contained barrelling machines for small batch work now being made by Roto-Finish, Ltd., Mark Road, Hemel Hempstead, Herts, is available in six, nine or twelve-drum models. If an increased capacity is required, an additional drum unit can be fitted on the basic machine and a standard twelve-drum model with a twelve-drum additional unit fitted can be seen in our illustration.

Plastic barrels of about ¼ cubic foot capacity

Self-contained barrelling machine with extra barrelling unit in position

are used with this design of machine and when filled the drums are placed in a hinged cradle forming the front panel of each barrelling chamber, as shown in the top right-hand corner of the machine in the illustration. When this cradle is swung up it is automatically locked, and the drum rolls back on to a line of rotating rollers for the barrelling operation. Each line of drum rollers is driven through chains and a clutch by a motor mounted in the machine. Through controls grouped on a panel below the lines of drums the required processing time is set and at the end of the pre-set period a drum cradle automatically swings down for the drum to roll into it off the driving rollers.

The bench front of the machine incorporates vibrating screens, chip bins, a washing sink and a drawer for storing special tableted compounds used in processing.

[Reply Card No. E3981]

Safety Tests of 25kV Traction System

A TECHNICAL demonstration of safety margins in the overhead system for the 25kV single-phase a.c. system of railway electrification was given recently by the British Transport Commission before Ministry of Transport officials, trades union representatives and railway officers at Colchester (St. Botolphs) station. The demonstrations showed the effects of reducing the clearance between the 25kV contact wire and a steam locomotive standing underneath it. To avoid unnecessary burning of the wire, test loops were hung from the main cable over the front portion of the locomotive and over the chimney. This also reduced the distance through which the contact wire had to be lowered to reduce clearance to the flashover point. Throughout the tests the locomotive emitted as much smoke as possible, with the blower on, since in these conditions flashover is likely to occur over a wider gap than in clean, dry air.

For the first test a man stood with one foot on a steel plate placed on the platform and the other on the locomotive. The steel plate was connected to the running rail to produce the same conditions as if the man were standing directly on the rail. During the test this man held on to the hand-rail of the locomotive. Others stood directly on the platform, also holding the hand-rail, and another man was on the footplate. The overhead line was energised at 25kV and the height of the contact wire was reduced to 11in above the chimney, then to 5in and finally 2in, at which distance flashover occurred. All these men were perfectly safe because the current went direct to earth through the locomotive. The standard height of the 25kV contact wire is 16ft and minimum clearance must be 11in above loading gauge height.

For the second test a dummy, with the same electrical resistance as a real person, was placed astride the boiler of the locomotive facing the chimney, in a slumped-forward position. Again, the overhead line was energised at 25kV and the dummy was pulled up into a sitting position; it was not until its head was less than 1in away from the wire that flashover occurred. Another demonstration was given, with similar results, with a dummy on top of the coal in the tender. Finally, high-voltage surges were applied to the wire to simulate conditions in a thunder-storm.

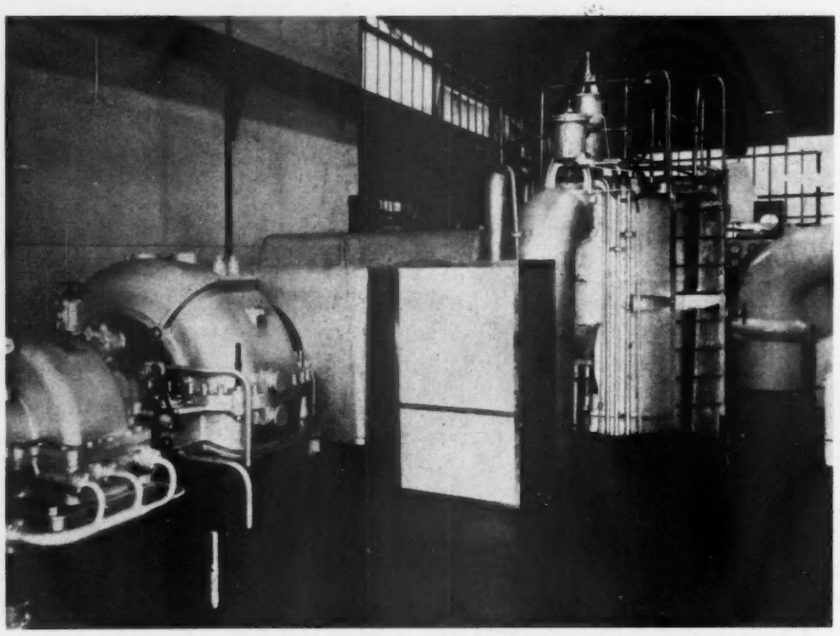
After the demonstration, Brigadier C. A. Langley, Chief Inspecting Officer of Railways, Ministry of Transport, said that the demonstration had illustrated most effectively three important facts. First, the clearances between the contact wire and a structure, whether moving or fixed, as laid down by the Commission and authorised by the Minister, provided an ample margin of safety. Secondly, there would be no danger to anyone legitimately on or in contact with an engine, if by any remote chance there was a flashover from the overhead wire, even if there was a high-voltage surge such as might occur during an electrical storm. Thirdly, the results of failure to obey the safety rules had been vividly emphasised by the experiments on the two dummies. Brigadier Langley added that the railway rule prohibiting men from working within 9ft of an overhead wire unless power was cut off had nothing to do with the distance through which electrical discharges might pass, but was a precaution against contact with the wire by any long piece of equipment or tool.

Blast-Furnace-Gas Turbo-Alternator

IN our issue of February 7, 1958 (page 213), we described the industrial gas-turbine alternator that had been built to Brown Boveri design by Richardsons Westgarth (Hartlepool), Ltd., for Shelton Iron and Steel, Ltd. It will be recalled that this set has a nominal rating of 2500kW, with a significant reserve capacity, the turbine inlet temperature being limited to 650 deg. Fah., and is designed to burn blast-furnace gas: it is, because of the need to provide a separate (in this case centrifugal) compressor for gaseous fuel, the smallest gas-burning set in the Brown Boveri designs.

The installation of the Shelton engine was completed rather less than a year ago, but until last autumn operation was on gas oil, since in the original installation the drainage of the blast-furnace gas supply line (the gas is washed with water before passing through electrostatic precipitators) was inadequate and water was liable to enter the engine as the load, and gas flow, increased: the presence of steam in the gas reaching the burner reduces the calorific value (normally 110 B.Th.U. per cubic feet) sharply—there is observed a transient increase in power due to the increased mass flow and a flame failure. These problems were eliminated by draining the gas line and the single-shaft engine is now found to follow the load as rapidly as a steam turbine. When blast-furnace gas is in short supply—the pressure in the main is not allowed to fall below 2in water gauge—the engine is fuelled with gas oil but, to avoid over-temperature due to inadequate mass flow, some gas must still be taken from the auxiliary compressor: since the auxiliary compressor cannot be changed to handling air without stopping the plant, the engine has to have priority over other works demands for blast-furnace gas. The change from gas to oil fuel is made manually, prompted by an automatic low-gas-pressure alarm, but automatic change-over, which would involve the addition of a flame failure monitor, is envisaged.

[Reply Card No. E3983]



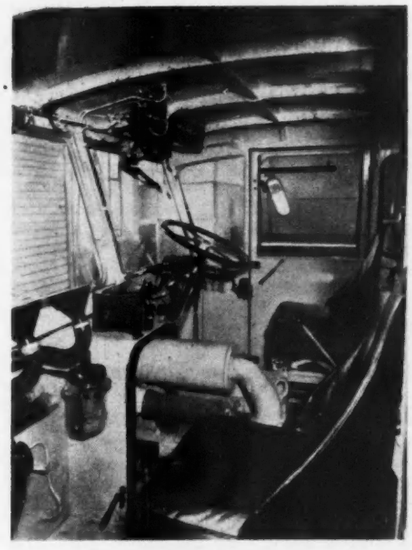
From left to right are visible the gear housing, main compressor inlet and (lagged) delivery, turbine, combustion chamber and trunking from recuperator. The two rams above the combustor are to move (nearer) the gas admission valve and (further) the retractable oil sprayer. The cubicle in front of the gas duct from the heat exchanger contains control gear moved from the control panel (right rear) to reduce lags in pressure piping

High-Speed Grit Laying

SEVEN vehicles specially built to spread grit on motorways have been acquired by the Ministry of Transport from Scammell Lorries, Ltd., Watford. Since the vehicle and the flying grit are in effect an obstruction, the vehicles have been built for operation up to 40 m.p.h. The chassis

The spreading of grit or salt at speeds up to 40 m.p.h. can be performed by this 8×6 Scammell ; the driver has control of the shields over each gritter

differs from accepted Scammell practice in being an 8×6, a second, undriven, front axle being provided to generate the high side forces involved in ploughing snow, while the undriven wheels are braked. Steering is power-assisted from a belt-driven hydraulic pump, while another hydraulic pump driven from the timing gears of the Leyland 0.680 engine drives the spinners under the centre of the 13/14-ton body. The conveyors carrying salt or grit forward and back



Driver's cabin in the gritter ; notice the screen de-frosting and washing equipment. The pipe passing through the roof supplies the air horn

to the spinners are driven from the power take-off of the two-speed transfer box. There is also a compressed air system, charging from the main engine air filter trunking by a methanol anti-freezer ; it supplies two separate brake systems, one for the first and third and the other for the second and fourth axles, both controlled by pedal and manual valves in the cab, and the windscreen wipers and washers. The windscreens have a reverse slope to facilitate shedding of snow forward, the semi-forward-control cab being reminiscent of a Canadian Military Pattern vehicle. Our second illustration shows that the design of the cab interior is also unusual. The ammeter, engine oil pres-pressure gauge, water temperature gauge (critically important in freezing environments, and air pressure gauge, each with a warning light, are mounted in a panel above the windscreen and close to the driver's line of sight. The speedometer, being mechanically driven, is on top of the engine cowling. Finish is in bright yellow paint of chlorinated rubber to resist the effects of wet salt. The body and gritting equipment was supplied by Atkinson Agricultural Appliances, Ltd., of Clitheroe, Lancs.

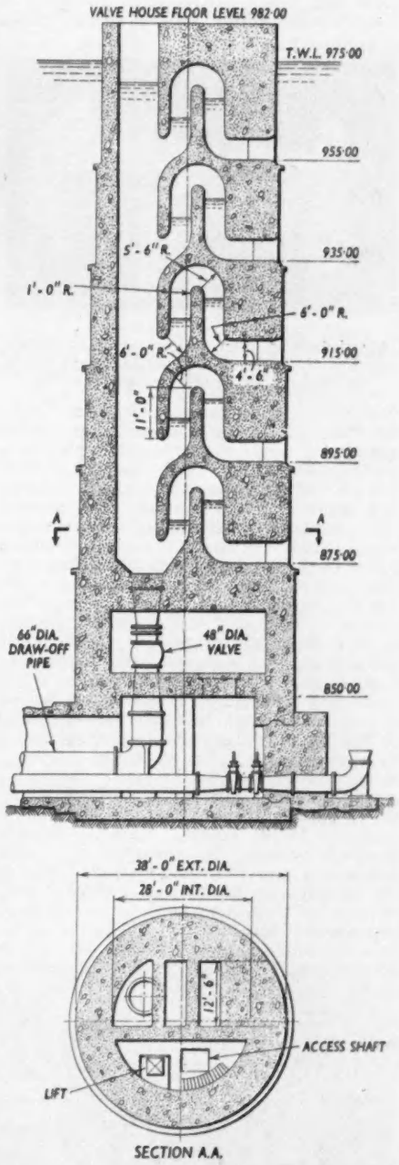
Draw-Off Tower at Tryweryn Reservoir

THE current issue of the *Journal of the Institution of Water Engineers* contains an article by Mr. G. Smethurst, of Messrs. Binnie, Deacon and Gourley, on an unusual draw-off tower which is to be constructed for the Tryweryn reservoir, a reservoir which is about to be built for Liverpool Corporation in North Wales. Outlets with a capacity of 250 m.g.d. at any of four working levels were called for, so siphons were decided upon in preference to valves, because of their longer life, elimination of faults in operation and less cost. The tower is shown in the accompanying sketch. The following details have been abstracted from Mr. Smethurst's article.

" When any one siphon is working, even at maximum flow, the loss of head across the siphon is relatively small, and this is reflected by the difference in level between the water in the reservoir and that in the vertical shaft leading to the outlet main. The other siphons can be locked by blowing in sufficient air to prevent water from flowing over the vertical division wall in the siphon. All controls are small and will be fitted outside the siphons in a dry well which runs the full height of the tower, giving access at all levels and affording a passageway for air pipes and indicator cables. Any draw-off or group of draw-offs can operate if all are not locked simultaneously. For this reason a single master-valve of conventional pattern has to be installed at the base of the vertical shaft which will automatically close in the event of a burst in the 66in main, which is unlikely because it would be of steel.

" A one : eleven-scale model of that portion of the tower that included the siphons and outlet shaft was built and tested by the British Hydromechanics Research Association. Running conditions were studied and head losses and pressure distribution within the siphons were measured at different rates of flow. A number of abnormal operating conditions were simulated, but little trouble could be induced, and control could quickly be re-established by simple methods. To gain a general picture of the response of the system over a wide range of operating conditions, and to find the effect on the response of changes in the parameters, it was decided to use an electronic analogue computer. Calculations showed that the surges in the shaft, on starting and stopping the model, were not large enough to break the air locks, and this was confirmed by measurements on the model.

" The model has demonstrated that the proposal to replace the valves in a draw-off tower by siphons is thoroughly practical and will work without difficulty. In a slightly amended



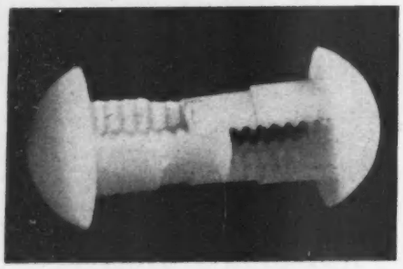
Proposed draw-off tower at Tryweryn reservoir

form it would appear that this principle could be applied to the design of sluice gates and even inlet gates controlling steeply inclined pipe-lines under high head. The amendment would consist of introducing two counterbalancing siphon sections, the main part of the differential head being replaced by a virtually weightless column of air. The difference in head between the legs in both siphons would be equal, and therefore the air seal would remain in place. As above, the ' gate ' would be opened or closed by introducing or releasing air under pressure."

SHORTER REPORTS *(Continued)*

Engineering Thermoplastic

THERE is now available in this country "Delrin," a product of the Polychemicals Department of E. I. Du Pont de Nemours and Co., Inc. This material is a high polymer of formaldehyde, and with properties rather or, in some respects, greatly superior to those of nylon, it is expected to find applications in engineering in place of metals chosen for ease of forming rather than good service, such as brass and zinc. The physical properties of "Delrin" are shown in the table ("500" material is intended for moulding, and "150" for extrusion); it can be moulded at 200–230 deg. Cent., rapid working being favourable to minimise degradation of the material, and is suitable for service in environments attaining 115 deg. Cent. intermittently. Particularly interesting properties are the high creep strength, which allows interference fits and self-tapping screws to be used without risk of their becoming loose, and retention of a fatigue limit up to 150 deg. Fah., which affords good service in gears. The material has a hard, glossy surface, and because of its extreme solvent resistance it is unlikely either to stain or to stick to other substances; it is unusual among plastics in that it can successfully be painted with acrylic and lacquer paints. It is not, however, recommended outside the pH range 4-11. Water absorption is low but definite. The friction of "Delrin" is low, between 0·1 and 0·3 with most other materials, and the static and dynamic coefficients are so closely the same that stick-slip cannot occur; "Delrin"-to-steel bearings are not known to squeak. An interesting application proposed is to use extruded "Delrin" tube as the compression member of control cables. Where particularly high dimensional stability or abrasion resistance is required, "Delrin" components should be annealed in an oil bath at about 320 deg. Fah., and this leaves an enduring oil film on the surface.



A self-clenching shear fastener or two-part rivet moulded in "Delrin" has particular application on belts passing through magnetic detectors

While the material is normally a creamy white, it can be self-coloured, with, if desired, decorative pastel shades; it is affected by ultra-violet radiation and parts for use in sunlight should be designed in a grade containing carbon black. It is a dielectric of good quality even after immersion in water or under high humidity, and its combination of mechanical and electrical properties have led to proposals that instrument panels be moulded in "Delrin" and provided with printed circuits. It is easily machined and is amenable to fusion welding; one successful technique of joining is spin welding, wherein one part is rotated rapidly in light contact with another until friction melts the interface.

"Delrin" is available in this country from the Du Pont Company (United Kingdom), Ltd., 76, Jermyn Street, London, S.W.1. Its moulding qualities were demonstrated to us on a Lester 4-6 oz automatic injection moulding machine, one of a range of machines distinguished by a vertical, internally resistance-heated cylinder assembly, a mechanical break-off of the material stream which allows the foremost portion of the plastic in each charge to be kept heated during the unloading portion of the cycle, and a highly repeatable mould height adustment afforded by driving the moving platen through a four bar chain, which are to be manufactured in this country by J. Brockhouse and Co., Ltd., Wolverhampton.

[Reply Card No. E4001 A or B]

TABLE

Property	Units	A.S.T.M. No.	Average values* for "Delrin" 500X	150X
Elongation, 73 deg. Fah.	Per cent	D638	16	75
Elongation, 158 deg. Fah.	Per cent	D638	330	460
Impact strength, Izod, −40 deg. Fah.	Ft lb/in	D256	1·2	1·8
Impact strength, Izod, 73 deg. Fah.	Ft lb/in	D256	1·4	2·3
Tensile strength and yield point, 73 deg. Fah.	Lb per sq. in	D638	10,000	
Tensile strength and yield point, 158 deg. Fah.	Lb per sq. in	D638	7,500	
Flexural modulus, 73 deg. Fah.	Lb per sq. in	D790	410,000	
Flexural strength	Lb per sq. in	D790	14,100	
Fatigue endurance limit, 73 deg. Fah., 100 per cent RH	Lb per sq. in	—	5,000	
Shear strength	Lb per sq. in	D732	9,510	
Heat distortion temperature, 264 lb per square inch	Deg. Fah.	D648	212	
Heat distortion temperature, 66 lb per square inch	Deg. Fah.	D648	338	
Deformation under load (2,000 lb per square inch at 122 deg. Fah.)	Per cent	D621	0·5	
Compressive stress at 1 per cent deformation	Lb per sq. in	D695	5,200	
Water absorption, 24 hours' immersion	Per cent	D570	0·4	
Water absorption, 50 per cent RH (equilibrium)	Per cent	D570	0·2	
Specific gravity	—	D792	1·425	
Rockwell hardness	—	D785	M94, R120	
Flammability	In/min	D635	1·1	
Melting point (crystalline)	Deg. Fah.	—	347	
Flow temperature	Deg. Fah.	D569	363	
Coefficient of linear thermal expansion	Per deg. Fah.	D696	$4·5\times10^{-4}$	
Thermal conductivity	B.Th.U/hr/sq. ft./deg. Fah./in	—	1·6	
Specific heat	Cal/gm.	—	0·35	

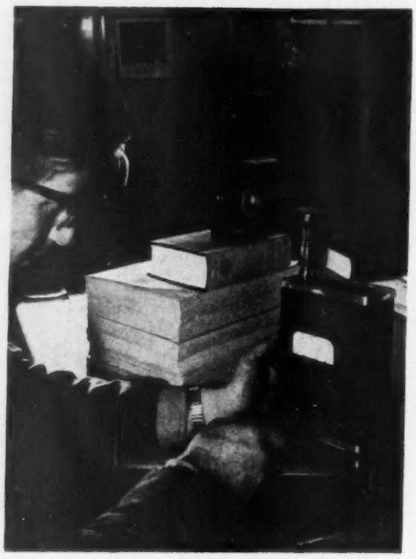
* These values are representative of those obtained under standard A.S.T.M. conditions and should not be used to design parts which function under different conditions.

Sound Measuring Equipment

A PORTABLE sound level meter using transistors throughout and operated by internal dry batteries has been introduced by Dawe Instruments, Ltd., 99, Uxbridge Road, London, W.5. The new instrument, Type 1400E, conforms to the proposed International Electrotechnical Commission (I.E.C.) specification for sound level meters, and is claimed to be the world's first commercially-available fully transistorised instrument for this purpose.

The unit comprises a crystal microphone, an impedance matching circuit, two attenuators, a high-gain amplifier, weighting networks, and an indicating meter. Both attenuators (one at the input and the other after the second amplifier stage) are operated by a single control knob to give direct measurement of sound level over the entire audio range from 24 dB to 140 dB. The three weighting networks simulate the frequency response of the human ear to low (40 phon), medium (70 phon) and loud (100 phon) noises. Meter readings therefore provide a close measure of the equivalent loudness of a noise without the variations of perception to which all human observers are prone to some extent.

The instrument may be held in one hand and is switched on by raising the microphone from its foldaway position in a recess in the case,



Setting up a transistorised sound level meter with the help of a falling-ball calibrator

when a reading is obtained at once. One set of dry batteries provides for about 60 hours' operation. A power pack is available for operation from a mains supply if mobility is not required. The meter also has an output jack into which a frequency analyser can be plugged.

The accompanying illustration shows the meter in use in conjunction with a Dawe Type 1417 falling ball acoustic calibrator (on left). This unit consists of a cast aluminium housing with two compartments, trunnion-mounted in a simple stand like an hour glass. Balls fall through an aperture in the top compartment on to an anvil which deflects them against a diaphragm, thus giving rise to the calibrating noise. The balls then pass through another aperture into a lower compartment. The rate at which balls strike the diaphragm is set during manufacture to give a noise of constant intensity and broad frequency spectrum (centred on 1500 c/s) throughout the life of the calibrator. By inverting the housing, the balls are returned to the original compartment. Since the sound level emitted by the calibrator is 90 dB, it is possible to calibrate with an accuracy of about ±1 dB against most normal backgrounds of noise.

[Reply Card No. E4002]

Sealing Tape for Threaded Pipe Joints

To provide a simple and effective means of sealing threaded pipe joints, a P.T.F.E. tape is now made by Crane Packing, Ltd., Slough, Bucks. This ½in wide tape is supplied in spools, and when making a joint a sufficient length is cut off to wrap around the thread with an overlap of about ½in. The tape is pulled taut so that it grips and sinks into the thread, and when the female member is screwed on the seal is complete. As the P.T.F.E. from which this "Threadseal" is made is self-lubricating it eliminates seizing, and joints can be easily broken after a long period in service as the material never hardens.

The tape, it is stated, can be used with any form of metallic or plastic pipe, whether carrying aggressive fluids such as corrosive chemicals or harmless liquids over a temperature range from −200 deg. Fah. to +500 deg. Fah. It is non-toxic and does not contaminate the fluid in a pipe system.

[Reply Card No. E4003]

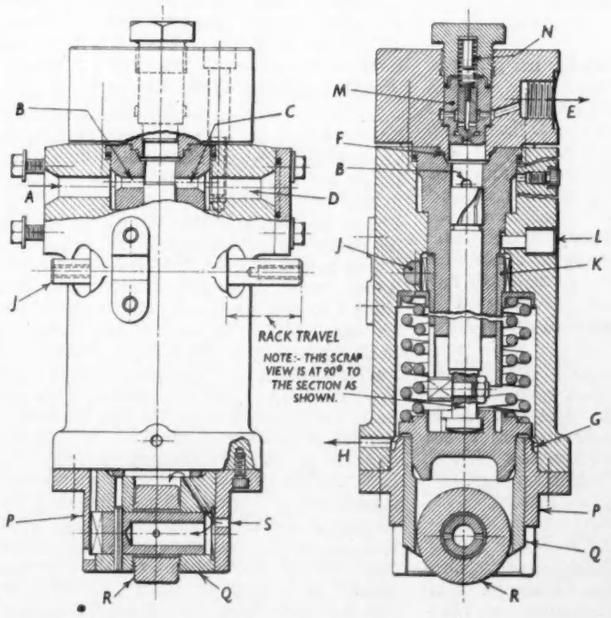
Fuel Injection Pump for Ruston "AT" Engines

THE four-stroke, direct injection, unidirectional "AT" engine was designed by Ruston and Hornsby, Ltd., after a study of long-term trends in engines and in demands for power. An electronic computer was employed to solve the design equation consisting of many variables and as finally resolved, the engine has a bore and stroke of 12½in by 14½in and a piston speed of 1200ft at 500 r.p.m. Units of five, six, seven, eight and nine cylinders are available in turbo-charged, or turbo-charged with cooling, form, and at 500 r.p.m. the continuous shaft horse-power, at the gearbox output coupling, ranges from 622 to 1120 and from 793 to 1420 for the respective versions.

In the detailed description of the engine which appeared in THE ENGINEER of March 6, 1959, there is a separate oil fuel pump for each cylinder controlled by a centrifugal governor through an hydraulic servo-mechanism. This pump is of Ruston design and, due to considerations of the space available, it had to be of exceptionally low height, with side outlet of the high pressure fuel supply to the injector.

The pump housing is of close grained cast iron and the pump plunger is of ball bearing steel ground and lapped into the pump barrel. From the drawing of the pump, which we reproduce, it can be seen that operation is through the rather unusual arrangement, for this size of pump, of a roller tappet which is supplied with lubricating oil under pressure to the roller bush and face. The stroke is 0·875in and the pump, which has a right-hand helix and a bore of 20mm, can accommodate a maximum plunger size of 24mm. A helix controlled spill port varies the output of the pump, the plunger being rotated by a rack and pinion which has a movement of 1 $\frac{11}{16}$in for 10 per cent overload, the fuel supply being 242 c.c. per 100 strokes. Any leakage of fuel past the pump plunger is collected in an annular well, formed between the top of the tappet guide and the pump housing, and drains into a tray surrounding the pump flange.

The fundamental departure from the orthodox, incorporated in the pump design, is the high pressure sealing arrangement between the pump barrel and the discharge valve head. The arrangement embodies the principle of the Graylock seal, a design the operation of which is based on elastic deflection within the elastic limit of the material forming the male member of the seal. This deflection is achieved by the provision of a slight angular difference between the faces of the male and female cones, the male cone having the smaller included angle. Assisting in the sealing process is the very high intermittent pressure, in the pump chamber, which is of the order of 14,000 lb per square inch. The bolts securing the mild steel head to the pump body take only the hydraulic loads imposed and only a low tightening torque of 40 lb per foot is required, thus eliminating distortion of the pump housing and valve head. When bolting down the head no special care against tilting is required and repeated removal and refitting of the head does not impair the effectiveness of the seal.



A—Fuel inlet.
B—Fill port.
C—Spill port.
D—Spill shock absorbing volume to eliminate spill erosion.
E—Fuel delivery to injector.
F—High pressure "Graylock" type seal.
G—Leakage fuel well.
H—Leakage fuel drain.
J—Fuel rack.
K—Pinion sleeve.
L—Pump barrel locating peg.
M—Delivery valve assembly.
N—Delivery valve lift stop.
P—Tappet guide.
Q—Tappet.
R—Tappet roller assembly.
S—Lubricating oil supply to roller bush and face.

General arrangement of fuel injection pump

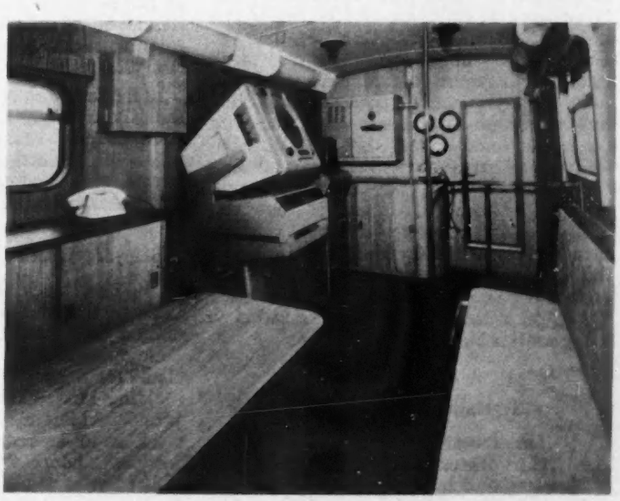
Radar Demonstrations for Europe

DEMONSTRATIONS of marine radar and associated apparatus will be given at thirty Continental centres in the course of a 5000-mile tour by a mobile radar unit operated by the Electronic Apparatus Division of Associated Electrical Industries, Ltd., 33, Grosvenor Place, London, S.W.1. The unit consists of a Karrier "Gamecock" tractor coupled to a drop frame semi-trailer by Carrimore Six Wheelers, Ltd. Power for operating the demonstration equipment and other services in the trailer is taken from an A.E.I. 6kW generator slung behind the cab and driven from the vehicle gearbox through a power take-off.

As seen in the illustration, two marine radars are installed in the trailer, comprising the "Escort" equipment in the foreground and an "RMS-2" beyond. These are similar equipments to those in the liner "Queen Elizabeth." The "Escort" radar and its multiple presentation facilities, including a true course display to dispense with plotting for interpreting situations which might be ambiguous in a relative display, were described in our March 20, 1959, issue. When using true course presentation the moving spot representing "own ship" is reset electronically by circuits using only eleven valves, and information controlling its motion is fed in automatically so that the operator can concentrate on the picture without the need for frequent readjustment of controls. A large reduction in the number of valves compared with other electronic resetting systems is claimed, together with greater simplicity than electro-mechanical systems in which potentiometers are adjusted by servo motors operating through dog clutches.

Power supplies to the trailer from the generator mentioned above are controlled by a "Magnestat" voltage regulator. Other marine equipment in the trailer includes standard marine and passengers' cabin telephones, signalling and bridge instruments, and enclosed fluorescent lighting fittings in which "Mazda" 2ft 20W tubes are operated on a 220V d.c. supply. A slotted waveguide scanner for the radar installation is mounted on the trailer roof. During its European tour the unit will give demonstrations at ports in Belgium, Holland, Germany, Denmark, Sweden, Norway, France and Italy.

[Reply Card No. E4012]



Mobile demonstration room for marine radar and other ships' electrical equipment

Spiral Point Twist Drills

PARTICULARS have been received from Charles Churchill and Co., Ltd., Coventry Road, South Yardley, Birmingham, of a form of spiral twist drill point developed by Cincinnati and known as the "Spiropoint."

This spiral point is produced on a special grinding machine, which imparts an actual point at the centre of the drill, as distinct from the conventional "chisel" point. With this spiral point, it is stated, the drill automatically centres itself on contacting the work and has no tendency to "walk." As a result the need for spotting a hole is eliminated and throughout a drilling operation the drill continues to centre itself, giving a clean, round, accurate and straight hole. The superior cutting action at the point is also claimed to reduce appreciably the thrust required to push a drill into the work.

On the machine developed to grind the "Spiropoint" drill the grinding wheel periphery is profiled to the required angle and the drill set in a vice with reference to a stop. During the grinding operation the wheel spindle travels round a circular path, set by means of a dial in accordance with the drill diameter, and oscillates the wheel at right angles to the drill axis.

[Reply Card No. E4013]

Acid De-Greasing Plant

AN installation for stainless steel acid de-greasing duties which has been supplied to a Government research establishment by Turner and Brown, Ltd., Davenport Works, Bolton, is made mostly of "Cobex" rigid p.v.c. reinforced with glass fibre. It includes 10ft by 20ft heated acid tanks with rim fume extraction equipment, fans, ducting, wash tanks, and soap and creosol tanks. The acid tanks are used for nitric acid at ambient temperature, a heated nitric and hydrofluoric acid mixture, and concentrated hydrochloric acid. The ducting of the rim fume extraction system forms an integral part of the tanks and gives unobstructed access to the tanks.

INDUSTRIAL NEWS

Budget Representations

This is the season in which the Chancellor of the Exchequer is offered advice by various authoritative bodies as to matters which might be considered in the formulation of his budget proposals. Within the past week, representations have been submitted to him by the Federation of British Industries and the Trades Union Congress.

The Federation of British Industries says its recommendations are based on its judgment of the country's general economic situation. For more than a year, the F.B.I. observes, the economy has been expanding at a satisfactory rate while prices generally have remained stable. The country's growing resources have been employed with increasing efficiency and, so far, it is claimed, the stresses and strains of inflation have been avoided. But, the F.B.I. points out, in some districts and in some parts of the economy, notably among heavy capital goods producers, revival has only lately begun and there is still a substantial amount of spare productive capacity. In this situation, the F.B.I. takes the view that no extraordinary fiscal measures of stimulation or restriction are appropriate. The possibility of renewed inflation is too real for any significant increase in the total budgetary deficit over the amount likely to arise in 1959–60 to be justified, even for the purpose of re-employing the capacity which is now unused. On the other hand, the F.B.I. asserts, inflation cannot be said to be so imminent as to require an increase in the "above the line" surplus.

The Trades Union Congress, in its representations, agrees that, compared with a year ago, there is a marked improvement in the economic situation, although, it says, many areas and several sections of industry are still relatively depressed. The Government now ought to be taking decisive steps, the T.U.C. urges, to put the economy on a sounder basis, particularly by expanding employment and output. But, it is urged, it is not enough to increase the capacity of industry to produce; industry must also be able to pay higher real wages and provide better working conditions for its employees. It is essential, the T.U.C. adds, that the Government should press forward with measures to ensure that the labour force is fully employed and to correct the existing maldistribution of industry compared with the labour force by more adequate distribution of industry policies. The Local Employment Bill, the T.U.C. thinks, is a move in the right direction. It suggests, however, that, in order to restore full employment in the areas of chronically high unemployment, the Government must be prepared to build and, if necessary, to operate factories itself if private industry cannot be persuaded to move to those areas.

Safety Regulations for Civil Engineering

The recent Barton bridge accident (see THE ENGINEER, February 19) has drawn public attention to the general question of safety in works of engineering construction, and on Wednesday, February 24, the Minister of Labour, Mr. Heath, was asked questions in the House of Commons by four members about safety regulations for this class of work, and whether the introduction of such regulations could not be accelerated. Mr. Heath stated that he proposed to extend the definition of "work of engineering construction" in the Factories Acts, to include virtually all civil and constructional engineering work, and he hoped to make regulations before Easter. A preliminary draft of special regulations covering lifting operations had been issued on February 17, he noted, regulations on general safety were being drafted, and a draft of regulations covering diving had just been published (the last-mentioned was noted in these columns last week). Supplementary questions put to Mr. Heath drew attention to the fact that the draft regulations to which he referred were originally formulated in 1945, and questioned whether the qualifications of the Ministry's inspectors were adequate.

Another development was the publication last week of a White Paper "Report on Safety and Health in the Building and Civil Engineering Industries, 1954–58," prepared by the chief inspector of factories. The report outlines the legal requirements relating to safety and health on building operations and works of engineering construction, examines some of the more important causes of such accidents and refers to some of the developments which have taken place in the methods of training for safety. The most encouraging of these developments, it states, has been the establishment of a number of safety training centres.

Unemployment

The Ministry of Labour has reported that, on February 15, there were 449,952 people registered as unemployed in Great Britain. That was about 11,000 fewer than a month earlier. Between January 11 and February 15, it is stated there was an increase of 6000 in the number of people registered as "temporarily stopped" and a fall of 17,000 in the number "wholly unemployed." The February total represented 2 per cent of the estimated number of employees and should be compared with 2·1 per cent in January and 2·8 per cent in February of last year.

In the five-week period ended February 10, the Ministry says, the employment exchanges filled 209,000 vacancies. The number of vacancies notified to the exchanges but remaining unfilled on that date was 257,000, which was 12,000 more than in January.

Shipyard Hours

Last week agreement was reached between the Shipbuilding Employers' Federation and the Confederation of Shipbuilding and Engineering Unions on the claim for a shorter working week in shipbuilding and ship repairing. As from Monday, March 28, the statutory working week is to be reduced from forty-four to forty-two hours without loss of pay. A settlement on similar lines has been reached in the engineering industry as noted on page 312 of our February 19 issue.

At a meeting, on Thursday of last week, Mr. G. H. R. Towers, president of the Shipbuilding Employers' Federation, emphasised to representatives of the union confederation that, in relation to a shorter working week, it was essential to the employers "to have much more than the expressed goodwill of the unions in overcoming the many difficulties which had been too long with them in the industry." Mr. Towers said the employers felt sure that the unions would show their goodwill and co-operation by undertaking to bring to the notice of local officials and individual members throughout the country the imperative need for the avoidance of disputes and lost time. The employers were sincere in their belief that, unless they could substantially reduce the amount of lost time in the industry, the prospects of meeting foreign competition were considerably lessened.

Manchester Ship Canal

At the annual meeting of the Manchester Ship Canal Company, last Friday, the chairman, Sir Leslie Roberts, said that for some time past the company had been concerned about the onerous obligations contained in the Manchester Ship Canal Act of 1885, in regard to the River Mersey in the Warrington area. The company was called upon to maintain a channel some 2½ miles long, 50ft wide and 8ft deep at low water. The tolls received for the traffic conveyed along that route were of a nominal nature, while the cost incurred in dredging the channel averaged nearly £115,000 a year during the period 1955 to 1958. In 1959, Sir Leslie added, the cost rose steeply to £211,000 and even with that unprecedented level of expenditure it was not possible to provide a satisfactory channel.

Sir Leslie went on to say that this was a burden which the company and the general users of the Port of Manchester should no longer be called upon to carry. Accordingly, it had been thought desirable to promote a Bill in the present parliamentary session for the purpose of seeking relief. As well as the matter just mentioned, Sir Leslie continued, it was proposed to seek an increase in the charges the company was permitted to make for the haulage by railway of shipment traffic between the Manchester Docks and traders' premises on the Dock Estate and in Trafford Park. The increase sought, Sir Leslie explained, merely reflected the reduction in the purchasing power of money since the charges were last revised in 1950. In addition, the Bill dealt with a number of miscellaneous matters. These included the closing of the Old Quay Lock at Runcorn and of one of the company's ferries, an extension of the powers of the harbour master in regard to pleasure craft, the incorporation with the Manchester Ship Canal Acts of some of the provisions of the Road Traffic Acts and the alteration or repeal of some sections of earlier Manchester Ship Canal Acts.

On general matters, Sir Leslie said that the country was on the threshold of greater progress in manufacturing methods. That emphasised the importance of the services provided by public utility undertakings.

PERSONAL AND BUSINESS

Appointments

MR. V. G. S. GOSS has been appointed sales manager of La Mont Steam Generator, Ltd.

MR. MATTHEW REID MOORE has been appointed general sales manager of Richard Sutcliffe, Ltd.

MR. PETER SPRAWSON has been appointed a director of The British Piston Ring Company, Ltd.

MR. C. H. SOPPET has been appointed apprentice education and training officer of Head Wrightson and Co., Ltd.

MR. FRANK C. YOUNG has joined the public relations division of Simms Motor and Electronics Corporation, Ltd.

MR. A. H. C. GREENWOOD, A.F.R.Ae.S., has been appointed an additional director of Vickers-Armstrongs (Aircraft), Ltd.

MR. BJORN ROSEN has arrived in this country to take up an appointment as managing director of Sandvik Swedish Steels, Ltd.

GROUP CAPTAIN E. A. WARFIELD has been appointed general manager of the Avica Group of Companies at Hemel Hempstead.

HAGAN CONTROLS, Ltd., one of the Plessey Group of Companies, announces that Mr. K. R. Sandiford has joined the company as general manager.

MR. J. E. SMITH, managing director of the National Gas and Oil Engine Company, Ltd., has been elected to the board of Mirrlees, Bickerton and Day, Ltd.

DR. DENIS REBBECK, deputy managing director of Harland and Wolff, Ltd., has been appointed a deputy Lieutenant for the County of the City of Belfast.

MR. C. J. SMITH has resigned his appointment with Dorr-Oliver Company, Ltd., and has joined Eimco (Great Britain), Ltd., as deputy manager, filter division.

THE CHAMBER OF SHIPPING OF THE UNITED KINGDOM announces that Mr. H. Hogarth has been elected president for 1960-61 and Mr. W. Errington Keville as vice-president.

MR. R. E. LANDSBERT has been appointed a director of Marryat and Scott, Ltd., and Marryat and Place, Ltd., two of the operating companies of Marryat and Scott Holdings, Ltd.

MR. F. E. WILSON has been appointed managing director of B. Elliott (Machinery), Ltd., and has also joined the boards of directors of Victoria Machine Tool Company, Ltd., and Cardiff Lathe and Tool Works, Ltd.

URQUHART'S (1926), Ltd., announces that Mr. R. H. G. Sutton, managing director, has been appointed in addition, deputy chairman of the company. Mr. G. T. Furman, technical manager, has been appointed a director.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., has announced that Mr. K. A. Fillmore has been appointed divisional sales manager, Leigh Works, in succession to Mr. D. I. S. Hinton who is taking up an appointment with B.I.C.C.-Burndy, Ltd.

THE FAIREY COMPANY, Ltd., states that Mr. Geoffrey W. Hall has relinquished his appointment as managing director but continues as chairman of the company. Mr. C. H. Chichester Smith has been appointed managing director; Mr. C. C. Vinson has been appointed an additional director, and Mr. L. S. Dawkins has been appointed an additional director, retaining his appointment as secretary.

RICHARD THOMAS AND BALDWINS, Ltd., announces the following changes in the management of its Ebbw Vale section: Mr. I. C. Gwynne, manager, sheet and tinplate departments, has been appointed assistant general manager (production); Mr. R. A. Lake (chief engineer), to be assistant general manager (engineering); Rear Admiral V. D'A. Donaldson (assistant to the general manager) to be assistant general manager (administration); Mr. E. L. Pope (manager, administration) to be consultant to the general manager; Mr. J. S. Blair (manager, coke and iron) to be production manager, coke, iron and steel; Mr. W. D. Jenkins (manager, tinplate departments) to be production manager, rolling mills; Mr. D. J. Jones (assistant manager, open hearth department) to be manager, steel and brickworks; Mr. W. C. R. Penry at present assistant manager, blast furnaces to be manager, coke and iron; Dr. G. R. Parkes at present assistant manager tinplate departments to be manager, tinplate departments.

BARROW IRONWORKS, Ltd., announces that Mr. Langton Highton has been appointed a director and has assumed the chairmanship of the company, in succession to Sir John Fisher, who has been acting chairman since the death of Mr. W. Killingbeck. Sir John Fisher retired from the chairmanship on March 1, but remains on the board of directors.

MR. BARRIE HEATH, managing director of Powell Duffryn Carbon Products, Ltd., and a director of other companies in the Powell Duffryn Group, has relinquished these appointments. Mr. R. Turner, M.I.Mech.E., acting managing director of Powell Duffryn Technical Services, Ltd., has joined the board of Powell Duffryn Carbon Products, Ltd., as deputy chairman, and Mr. F. W. Stokes, a director and works manager of the company's factory at Hayes, has been appointed general manager.

Business Announcements

TIMBER DEVELOPMENT ASSOCIATION, Ltd., states that the address of its Midlands regional office is now 55, Pershore Street, Birmingham 5 (telephone, Midland 1079).

SQUARE D, Ltd., has opened an additional field office at Lloyds Bank Chambers, Wellington Street, Morley, Leeds (telephone, Morley 369), under the management of Mr. P. Wyar.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., states that as from Monday, March 7, its "Panelec" heating division will be transferred from 21, Bloomsbury Street, to 83-85, Saffron Hill, London, E.C.1 (telephone, Holborn 3994).

THE PRESS AND SHEAR MACHINERY COMPANY, Ltd., 172-178, Victoria Road, Acton, London, W.3, has been appointed the exclusive distributor in the United Kingdom for Theodor Grabener, Werthenbach/Kreis Siegen, Germany.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., has announced the formation in its radio and electronic components division of a new product department devoted to semi-conductors. The semi-conductor department has its sales organisation at 155, Charing Cross Road, London, W.C.2; Mr. F. Szekely is sales manager.

HOZELOCK, Ltd., announces that it has acquired the sole manufacturing and selling rights of the hose fittings previously manufactured by the engineering division of Airtech, Ltd. Sir Eric Ohlson, Bt., is chairman of the new company, Mr. F. S. G. Codling, managing director, and Mr. P. J. Langdon, sales manager.

ROTINOFF MOTORS, Ltd. and ROTINOFF ENGINEERING, Ltd., have been amalgamated and are now known as Lomount Vehicles and Engineering, Ltd. The associate companies, Rotinoff Construction, Ltd., and George Rotinoff, Ltd., have also been amalgamated and are now known as Lomount Construction, Ltd. The address of the newly named companies is Sackville House, 40, Piccadilly, London, W.1 (telephone, Regent 2112-6).

THE YALE AND TOWNE MANUFACTURING COMPANY has now put its "Trojan" tractor shovel into production at its British Materials Handling Division, Wednesfield, Staffs. The Allison "Torqmatic" transmission is retained, but a Leyland UE-350 engine rated at 105 h.p. at 2200 r.p.m. will be used in the 12,000 lb lift 154 LD model. The "Yale Tractor Shovel" will be marketed in Great Britain and Northern Ireland exclusively by Jack Olding and Co., Ltd., Hatfield, Herts.

THE CAPE ASBESTOS COMPANY, Ltd., 114–116, Park Street, London, W.1, has announced the formation of a company, Bruno-Cape SA., in conjunction with Bruno y Cia Com E Ind SRL, of Buenos Aires, and with the Johns-Manville International Corporation of U.S.A. Cape Asbestos has also entered into an agreement with Montisol Argentina SRL, to produce its "Caposite" amosite asbestos insulation materials (blocks and pipe sections) under licence and to Cape Asbestos standard specification.

E.M.I. ELECTRONICS, Ltd., Hayes, Middlesex, announces an agreement under which the Fairbanks Whitney Corporation of New York undertakes to market most of the electronic equipment designed and manufactured by E.M.I. Electronics, Ltd., a member of the Electric and Musical Industries group. Fairbanks Whitney will also manufacture some of the British company's equipment under licence. H. L. Hoffman and Co., Westbury, Long Island, will continue to promote the sales of certain E.M.I. Electronics products, and will co-operate with Fairbanks Whitney.

EFCO, Ltd. and STEIN AND ATKINSON, Ltd., announce that they have joined forces in a new company, Foundry and Metallurgical Equipment Company, Ltd., with headquarters at Netherby, 161, Queens Road, Weybridge, Surrey. This company will design, manufacture and supply foundry equipment including gas- and oil-fired crucible melting furnaces, gas, electric and oil-fired annealing furnaces and ovens specifically for foundry use, batch and continuous core stoves, core blowers, mould driers, sand driers, shell moulding and mould closing machines and gravity die casting equipment. In addition, they will manufacture and supply, under licence, the Efco-Diamond rotary reactor for desulphurising iron and steel by a new method developed in the U.S.A. by the Diamond Alkali Company. The company will also offer complete hot-blast cupola plants embodying air heaters of the "Escher" type and with the latest water jacketed reaction zone. Arrangements have been completed with Sinex Engineering Company, Ltd., for the new company to offer Sinex vibratory equipment for knock-out grids, screens, feeders and conveyors for the foundry industry and with Aldridge Industrial Oils of Cleveland U.S.A., for the sale of die lubricants. The directors of the new company are: Mr. D. F. Campbell (chairman), Mr. C. J. S. Atkinson, Mr. J. A. Monks and Mr. C. H. Williams. The consulting metallurgist is Dr. A. G. Robiette.

Contracts

THE BRIGHTSIDE FOUNDRY AND ENGINEERING COMPANY, Ltd., has received an order from The Brymbo Steel Works, Ltd., for the installation of a 32in blooming mill. The English Electric Company, Ltd., is to supply the electrical equipment for the mill.

MOON BROTHERS, Ltd., Birkenhead, has supplied a drum-making plant worth about £22,000 to the Indian firm of Mettur Chemicals and Industrial Corporation, Ltd. The plant, which is being installed at Mettur dam, is for the manufacture of 280mm, 355mm and 500mm drums for chemicals and is capable of turning out 900 drums a day.

WOODALL-DUCKHAM CONSTRUCTION COMPANY, Ltd., has received an order from the Sierra Leone Development Company, Ltd., to build an ore preparation plant valued at more than £300,000. The plant, which will be built at Marampa, will be capable of dealing with 110 tons of crude iron ore per hour. Constructional work will commence in September of this year and will be completed by June, 1961.

FAIREY AIR SURVEYS, Ltd., has been awarded a contract by the Highways Department of Essex County Council for an aerial survey for the improvement of the A.12 London to Great Yarmouth Trunk Road, between Chelmsford and Hatfield Peverel, covering aerial photography and mapping of 4½ miles of road. The air survey, including provision of maps and cross-section drawings of the road, is expected to be completed within four months.

THE HEAD WRIGHTSON MACHINE COMPANY, Ltd., has received from The Steel Company of Wales, Ltd., an order for the supply of a high speed cut-up line for the Abbey Works, valued at about £233,000. This line will take coils of cold rolled strip weighing up to 56,000 lb and convert them into sheets of different lengths. The cutting to length is carried out at speeds of up to 700ft per minute. After cutting up, the sheets will be automatically sorted and piled into packs of up to 40,000 lb in weight.

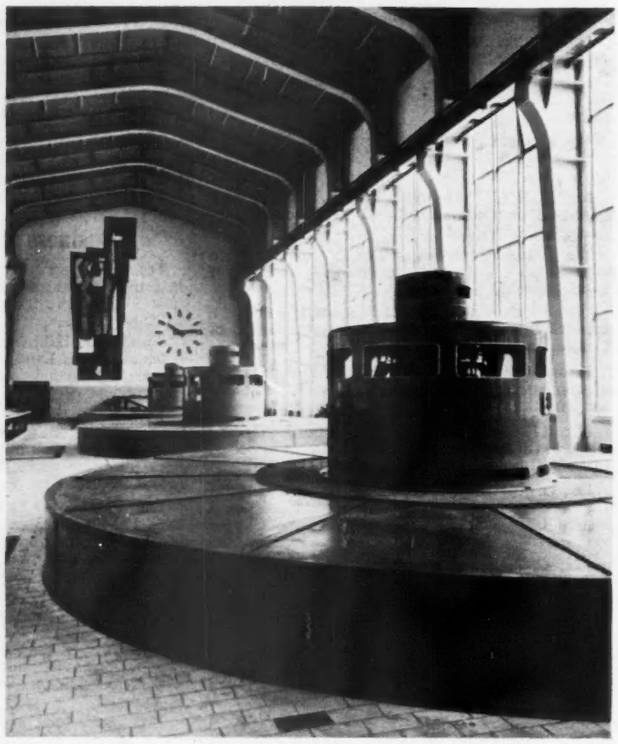
THE GENERAL ELECTRIC COMPANY, Ltd., has been awarded a further contract, valued at £2,000,000, for power plant and electrical equipment by Colvilles, Ltd. The plant and equipment is for extensions to the power house at Colvilles' Ravenscraig Iron and Steel Works, near Motherwell. Included in the contract are two turbo-generators, one of 20MW, 30MVA, and one of 12MW, 28MVA capacity; a turbo-blower rated 90,000 c.f.m., 40 lb per square inch gauge; a 200,000 lb per hour gas-fired boiler; feed heaters, condensers and ancillary plant; and all the motors, switchgear, transformers and cabling for auxiliary services. Also being supplied are two 30MVA, 33/11kV transformers and the necessary 33kV and 11kV switchgear. G.E.C. is acting as main contractor for the whole of the power house extension, including civil works and auxiliary services. In addition to this, G.E.C. will manufacture a nineteen-panel 33kV switchboard for a new sub-station taking a supply from the South of Scotland Electricity Board's 275kV grid. This switchgear will be linked to the power station through two 30MVA reactors.

CONTINENTAL AFFAIRS

by Our Continental Editor

Schwarzach Power Station

In the following article we describe the first power station on the Middle Salzach which was completed last autumn. Equipped with four sets of 30MW, it has a mean annual generating capacity of 482GWh, 35 per cent of which is in the winter months. This figure may be compared with the net annual output of Glockner-Kaprun (312MW) of 615GWh, of which, however, 76 per cent is winter power. The exploitation of the Salzach was made economically feasible by the building of Glockner-Kaprun which increases the winter flow of the river. In return, Schwarzach is able to supply pumping power to Kaprun in the summer. Although only of medium size, Schwarzach is of technical interest because of its 17km-long diversion tunnel, artificial storage reservoir and other aspects, some of which are dealt with in the article. The owner, Tauernkraftwerke A.G., Salzburg, one of the large power corporations set up under the 1947 law, now operates six power schemes, with a total generating capacity of 1512GWh, from an installed capacity of 540MW.



ONE of the principal regions of hydro-electric power generation in Austria is the Hohe Tauern massif, a part of the central range of the Alps containing the country's highest peak, the Grossglockner. Here, large catchment areas, including some important glaciers, occur in conjunction with high heads, and it is not surprising that plans for the harnessing of this power potential should have been made quite early in the history of water power. The advantage, indeed the necessity, of planning on a regional scale were soon appreciated. Perhaps the most important of these projects was that of the A.E.G. engineer, Münch (1928), who proposed the establishment of 1200km of contour aqueducts at about 2200m sea level on both sides of the watershed. The impounded waters were to be conveyed to the northern side of the range and utilised in two or three large power stations. Besides its high cost, there was also the objection against this plan that only 35 per cent of the power would be generated in the winter. It was perhaps fortunate that the Münch project was never carried out in that form, for progress in the art of constructing high dams, and the introduction of large pumping sets, has since made it possible to design a different scheme which shifts the major percentage of the output to the winter months when the demand is highest.

This is the Glockner-Kaprun development which in its present form was completed in the years 1949 to 1957. Its two stages have an installed capacity of 312MW and it comprises three large reservoirs totalling 173hm³.* With the commissioning of its pumping plant its output in 1958 amounted to 663GWh† of which about three-quarters is winter power. This is equal to about 7 per cent of the whole Austrian hydro-electric production and 5 per cent of the hydro-electric and thermal generation combined. This major post-war achievement of Austrian engineering enterprise has been described in detail in a series of articles in this journal,‡ so that this brief résumé may be sufficient for our present purpose.

Within the framework of the regional hydro-electric development plan, Glockner-Kaprun and the smaller power station of the Austrian Federal Railways in the neighbouring Stubach Valley, with the 15·7hm³ Weissee reservoir, are of great importance, inasmuch as their existence made possible the economic exploitation of the Salzach. This river, which originates a few miles to the north-west, at first flows east in a direction parallel to the Hohe Tauern range before turning left to break through the northern limestone mountains into the plain, eventually to join the river Inn, before it flows into the Danube. With its right and left bank tributaries, the Salzach drains the northern slopes of this part of the Tauern mountains as well as part of the limestone Alps (Fig. 1).

Before the commissioning of the Glockner-Kaprun scheme, the flow characteristics of the Salzach were those characteristic of a mountain river, dropping to low values in the winter, and rising to a high peak when the snow melted on the high ground during the summer. In Fig. 2 may be seen the flow characteristics in the mean hydraulic year, at the power station intake near Gries, a point where observations have been made since 1893; the influence of Kaprun is indicated on the graph. It may be seen that while previously the average flow ranged from about 14 cubic metres per second in the month of February, to about 123 cubic metres per second in July, the Kaprun reservoirs reduce the peak flow by about 10 cubic metres per second, while adding something like 17 cubic metres per second during the critical period December–February, which nearly doubles the water available for power production. If necessary the whole Kaprun storage can be exploited during those three months.

TABLE I—*Basic Data of Schwarzach Power Station*

River Salzach at Gries before construction of Glockner-Kaprun :	
Catchment (natural)	1378 square kilometres
Glaciation	7·9 per cent
Mean flow, winter	362·1hm³
Mean flow, summer	1393hm³
River Salzach at Gries, after construction of Glockner-Kaprun :	
Catchment (including Möll transfer)	1450·3 square kilometres
Natural flow, winter	362·1hm³
Glockner-Kaprun reservoirs	173hm³
Weissee reservoir	15·7hm³
Möll and Leiterbach transfer	14hm³
Total flow, winter	564·8hm³
Less statutory spillage	23·8hm³
Mean flow, winter	541hm³
Natural flow, summer	1317hm³
Less spillage	226hm³
Mean flow, summer	1091hm³
Output, winter	168GWh (35 per cent)
Output, summer	314GWh (65 per cent)
Output, total annual	482GWh (100 per cent)
Diversion tunnel :	
Length	16963m
Section	23·3 square metres
Flow capacity (reservoir full)	65 cubic metres per second
Flow capacity (reservoir empty)	85 cubic metres per second
Impounding level	738m sea level
Flood capacity of weir (maintaining 738m level)	900 cubic metres per second
Reservoir capacity, total	1·64hm³
Reservoir capacity, useful	1·48hm³
Highest reservoir working level	738m sea level
Lowest reservoir working level	715m sea level
Mean tail-race level	589m sea level
Turbines :	
Four Francis, h.p.	44,900 each
Speed, r.p.m.	375
Runaway speed, r.p.m.	715
Generator installed capacity, MW	4×30
Generator rating, MVA	4×35
Power factor	0·9
Generating voltage	10·25kV±7·5 per cent

* 1 hm³ = 1 cubic hectometre = 10^6 cubic metres.
† 1GWh = 10^6kWh.

‡ THE ENGINEER, September 14, 1956, page 379; September 21, 1956, page 417; September 28, 1956, page 452.

During the winter (October to March) the mean quantity available at Schwarzach power station is 541hm³, equivalent to about 168GWh. This quantity is made up of the natural flow of the Salzach of 362·1hm³ previous to the completion of the Kaprun and Weissee reservoirs, which together contribute 188·7hm³, plus 14hm³ transferred from the rivers Möll and Leiterbach south of the Tauern watershed, less the statutory spillage of 23·8hm³.

In the summer months (April to September), the useful flow is 1091hm³, equivalent to 314GWh, making an annual total of 482GWh.

Layout

Neither the " Upper Salzach " from the source as far as Bruck, nor the lower section from Golling to the Inn, are of much importance for power generation, on account of the low gradients of those reaches. On the other hand between Bruck and Golling, i.e. approximately between the confluence of the Kaprun waters and the point where the Salzach emerges from the hills, there is a difference in level of about 290m. The various proposals for utilising this head fall into four principal categories.

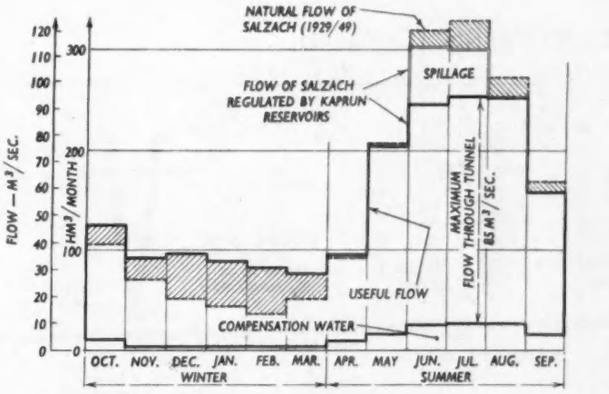
Some of the projects suggested exploitation in one or two stages only. One envisaged an aqueduct from Bruck via Zell to Saalfelden and from there through German territory, possibly using the Königsee lake. This idea, originally evolved by the A.E.G., Berlin, subsequently was not considered feasible. Another possibility was to construct a tunnel approximately 42km long between Bruck and Golling, following the slopes of the Hundstein and crossing the ranges of the Steinernes Meer and Hagengebirge. Geological considerations were against this plan, especially the widespread porosity of the limestone which threatened unpredictable but possibly heavy flooding ; moreover, to impound the river at the point suggested where its gradient is flat would have caused serious silting as far as Gries, and would also have adversely affected the drainage of neighbouring moors.

At the other extreme, plans had been drawn up during the war for thirteen run-of-river stations. Since that time, however, the valley became settled more densely, and much silting occurred near Werfen. The shifting of roads and of the main railway line which would have become necessary, contributed to making this approach appear uneconomical.

The solution which was eventually adopted was a combination of these ideas. It was decided to exploit something like half the total head in a single stage, extending from Gries, either along the left bank, possibly as far as St. Johann, or on the right bank to Plankenau, and to construct at some later date up to eight run-of-river plants along the lower remaining section. The most important of these eight stations is Golling, where a gross head of 30m could be created by means of a 2·5km-long diversion tunnel in good limestone rock, permitting the installation of a generating capacity of 40MW. For the first part of this scheme a number of variants were studied. From the point of view of constructing the long diversion tunnel required, the right bank of the Salzach on the whole offered the better geological conditions. Although it was desired to build the station for peak load operation, the existence of the large reservoirs upstream at Kaprun made it possible to achieve this aim by installing a large daily storage basin either at the tunnel intake or at the power station. An intake near Bruck, with or without a reservoir at that point, would have provided an additional 10m of head, as compared with an intake further downstream at Gries, but this gain would have been more than offset by the cost of an extra 6km of tunnel in unfavourable geological conditions, besides causing the drainage and silting difficulties mentioned. A reservoir upstream of the tunnel would also have necessitated increasing the tunnel cross-section.

For these reasons it was decided to place the intake at Gries. The power station was to be sited at Schwarzach, giving a gross head of about 150m. The storage basin was to be at the tunnel exit, where a suitable site was available. The layout of the plant in plan and elevation is illustrated in Fig. 3.

The installations comprise the following principal parts : a weir and intake screens situated about 1¼km below the town of Gries; an intake channel with sand removal plant; the tunnel, approximately 17km long followed by a daily storage reservoir of 1·5hm³ capacity; a penstock about 1km long ; the power station by the river upstream from Schwarzach ; and a 2000m-long tail-race.



FLOW IN HM³	114	91	94	87	81	74	86	189	220	228	226	142	1632
	541						1091						
GENERATION IN GWh	35	28	30	27	25	23	26	56	62	64	63	43	482
	168						314						

NOTE :- HM³ = CUBIC HECTOMETRES, = 10^6 CUBIC METRES.

Fig. 2—Distribution of annual flow at Gries, showing effect of Glockner-Kaprun scheme

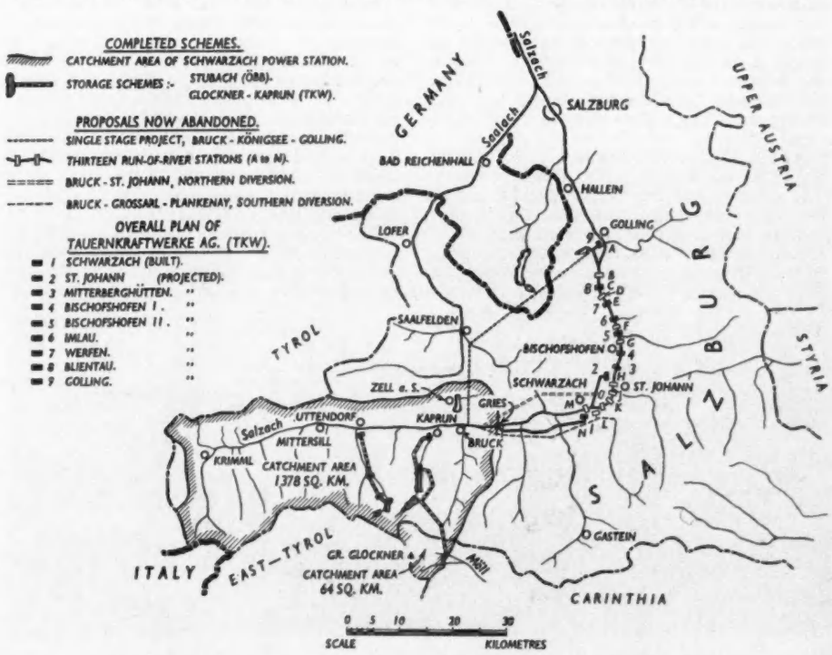


Fig. 1—Various proposed schemes for the exploitation of the Middle Salzach

Intake

The aggregate catchment area of the Salzach and its tributaries above the intake to Schwarzach power station amounts to 1450·3 square kilometres, including 72·3 square kilometres to the south of the Tauern watershed obtained through the artificial transfer of the headwaters of the River Möll.

With the daily storage basin filled, the design flow of the diversion tunnel is 65 cubic metres per second. This figure was arrived at as the sum of the largest winter flow of the Salzach (20·6 cubic metres per second) ; plus the peak discharge from the Kaprun stations during the winter months (32 cubic metres per second) ; plus an additional quantity when the projected Krimml reservoirs come into operation.

In the summer the flow can be increased to 85 cubic metres per second by lowering the level in the storage basin and operating as a pure run-of-river plant. A flow of at least 10 cubic metres per second must always be maintained in the river bed, and the flushing water from the sand removal plant is used for this purpose. The intake is therefore capable of taking a flow of up to 95 cubic metres per second.

Weir.—Above the point chosen for the site of the weir at river kilometre 154·23, the river could be impounded for only 1·5km in order to protect the drainage of the Zeller Moor and Lake. The impounded level is 738m above sea level. The weir comprises three sector gates surmounted by flaps (Fig. 4), a design chosen because of its robustness, especially to floating ice, and ease of maintenance. The weir is designed to pass a flood of 600 cubic metres per second with one section blocked, or 900 cubic metres per second through all three gates. The subsoil of fine gravel and sand demanded a slab foundation in the form of a reinforced 1·6m thick slab which is continuous over the full width of 45m, to prevent uneven settlement which might affect the mechanical functioning of the gates. The slab is protected against scour by a 12m deep apron of sheet piling at the upstream edge and a similar apron, 7m deep, downstream. Uplift pressure is dissipated by incorporating bell-shaped cavities in the foundation which are connected to rising ducts in the piers. The shape of the granite-clad stilling basin was studied at the Federal Hydraulic Research Station with a 1 : 40 full-scale model. Under a flow corresponding to 600 cubic metres per second through two weir sections only, strong lateral vorticity caused excessive downstream scour, so that in the full size structure the bed immediately downstream is protected by a heavy layer of rock.

The piers are 3·5m thick upstream, rounded at the leading edge, and vertically prestressed. Air

CONTINENTAL AFFAIRS *(Continued)*

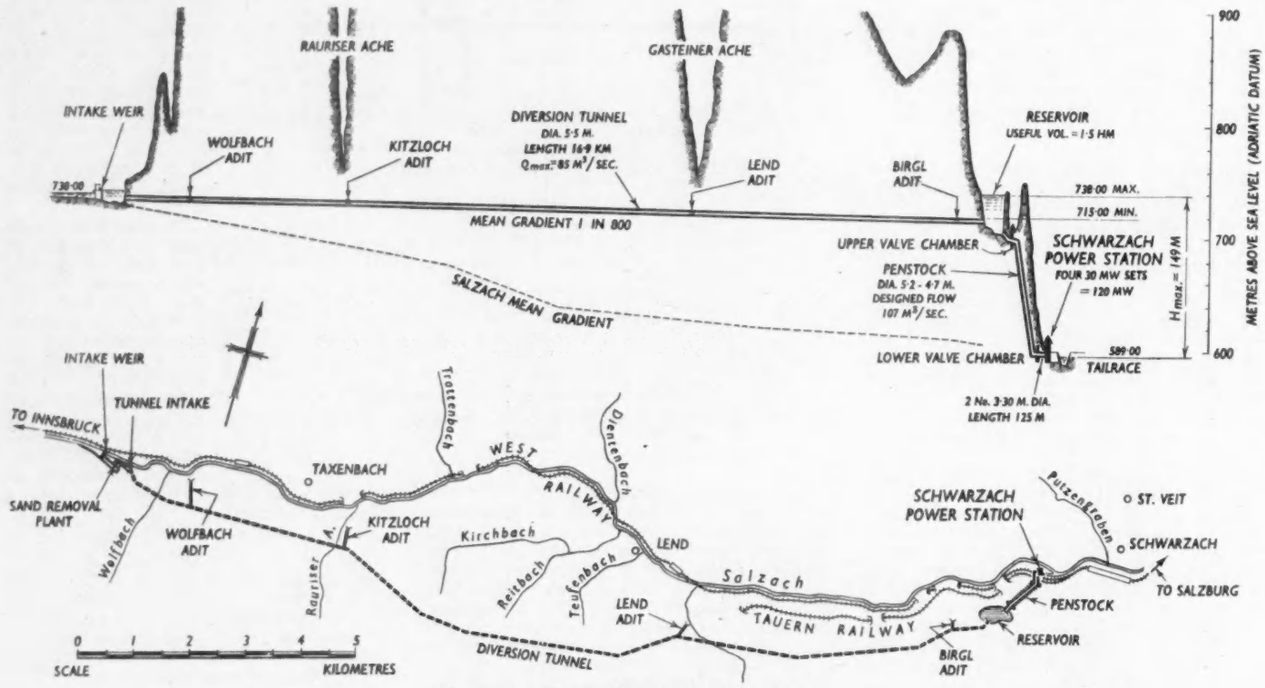


Fig. 3—Layout of Schwarzach diversion scheme

shafts and vents prevent the development of negative pressure under the overtopping sheets of water. Below the weir the piers carry a road bridge.

The gate and top flap of each section are operated by separate electric hoisting gear, the two sides being synchronised by an electric shaft. The top flaps are automatically controlled in conjunction with the inlet control gate, to maintain a head water datum of 738m sea level. On reaching the " fully open " flap position, the automatic control is switched off and an acoustic signal warns the weir keeper, who then adjusts the sector gates by hand.

Special steps had to be taken in the impounding zone to raise low-lying areas on the left bank and, in particular, elevate the main railway line for 1300m by 2·19m, which was done by siting the track on the river embankment. Including the connecting ramp downstream of the weir, about 2km of railway line was rebuilt.

Intake Structure.—The diversion intake structure immediately adjoins the weir on the right bank and is formed by an oblong basin, bellied to maintain streamline flow, and protected by screens covering 109 square metres and convex towards the upstream side. Below the screens an electrically-operated gravel discharge gate of 2m by 2m section returns heavy sediment to the river. At the far end of the basin is the inlet to the open channel, protected by a set of double gates of 9·5m width and 3·8m overall height ; the channel section, 9·5m wide and 4·1m deep, is formed on the side of the river by a concrete retaining wall which extends 0·5m above water level and is protected against scour by 6m deep sheet piling ; the land side of the channel has a 2 : 3 slope. After a 60m-long entrance section, the channel continues for about 230m with a bottom gradient of 1 in 1560. About 30m in front of the sand removal channel is a trap for heavy sediment in the shape of a transverse channel 2m wide and 1·8m deep, protected by a horizontal screen with 40mm spaces, and discharged periodically through a hand-operated gate.

Sand Removal Channels—Although the Tauern reservoirs and the flatness of the upper course of the River Salzach prevent excessive transport of sediment, the annual quantity passing Gries is estimated at 20,000 to 30,000 cubic metres. Two sills, one 3m high at the intake screens, where the maximum speed of flow is 0·93m per second, the other 2·4m high at the channel inlet, exclude about two-thirds of this burden. Nevertheless, the remainder, which ranges down to a grain size of about ¼mm, has to be prevented from settling in the daily storage reservoir from which removal is difficult. Because of lack of room at the intake for the normal kind of device, and the absence of an adequate head between channel and river, it became necessary to adopt a special design, comprising fifteen small chambers (Figs. 5 and 6). These have an individual width of 5m, a mean height of 4·5m and length of 25m ; under these conditions, with a mean section of 17·5m, the average speed is 0·33m per second, which is adequately low to permit grain sizes down to 0·6mm to settle within the length of the chamber. The sediment collects in the bottom trough, from which it is flushed continuously. Should a trough tend to fill up, an upper flushing system is brought into operation.

As Fig. 5 shows, the chambers are set at about 45 deg. to the direction of the diversion channel. The depth varies from 4·25m to 6·1m and the silo-shaped bottom slopes downstream at a gradient of 1 in 26, while the 50cm wide bottom trough slopes at 1 in 21. The inlet and outlet of each chamber are controlled by stop plates. Stilling screens are fitted behind each composite inlet stop plate. The outlet spillways can be adjusted between levels 735·8m and 736·7m by adding sill pieces, in order to equalise the flow of different chambers. By means of gates, the upper and combined flushing channels can be controlled. For winter operation, the number of chambers in use can be reduced to three.

A 125m-long open channel leads from this plant to the tunnel inlet, where a multiple butterfly gate comprising six streamline profiles rotatable about their horizontal axes is used to maintain the level in the sand removal plant as near as may be at the intake datum of 738m.

Diversion Tunnel

In order to divert the waters of the Salzach from Gries to Schwarzach, it was necessary to construct a 17km-long tunnel through the mountains along the right bank of the river, with overburdens of up to nearly 700m. A geological survey of the area had shown the presence of limestone, mostly in the eastern part of the route, while the major proportion consisted of various phyllites and mylonites. In view of the irregularity and rapid fluctuation of the strata, it was impossible to forecast very precisely the conditions which would actually be encountered.

The whole project was divided into four sections, with lengths and dates spaced according to the anticipated difficulties in such a way as to make possible simultaneous completion by mid-

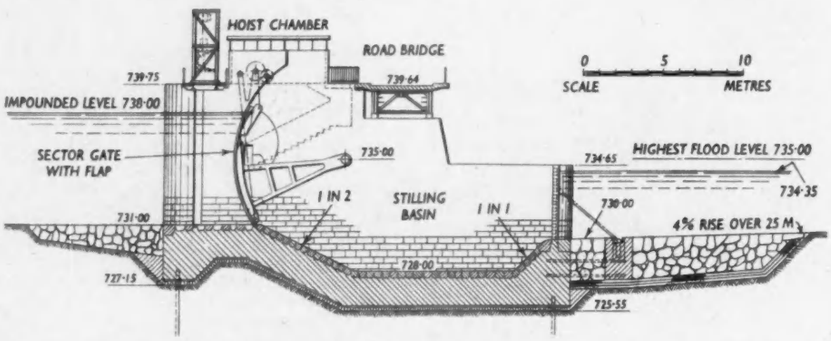


Fig. 4—Sectional elevation of intake weir

TABLE II—*Schwarzach Diversion Tunnel.*

Section	(1) Wolfbach	(2) Kitzloch	(3) Lend	(4) Birgl
Adit length	554m	358m	350m	206m
Distance of adit from tunnel entrance	1428m	4310m	10942m	16,172m
Length of section	1904m	4379m	6258m	4425m
Upstream section	1428m	2406m	4706m	3640m
Downstream section	476m	1973m	1552m	785m
Rates of driving (metres per day) (in brackets: scheduled rates) :				
Pilot tunnel	8·0 (7)	10·5 (7)	8·7 (6·25)	(Not carried out)
Full section	6·5 (7)	13·5 (7)	9·0 (6·25)	10·5 (7)
Lining	8·6 (7)	16·0 (7)	10·0 (6·4)	15·0 (7·5)
Compressors :				
Number of units	4	4	8	4
Output, cubic metres per second	82	106	166	105
Ventilating fans :				
Number of units	2	4	4	4
Output, cubic metres per second	4	8	7·5	7
Diesel locomotives :				
Number of units	16	14	16	14
Horsepower	500	600	850	625
Tubs :				
Number of units	70	80	110	100
Capacity, cubic metres	152	194	245	215
Loaders	Salzgitter	Salzgitter Sohlbagger	Salzgitter Sohlbagger	Salzgitter
Concreting	Placer	Torkret pumps	Placer and Torkret	Torkret pumps
Explosives, tons	84·9	185·2	278·0	255·0
Portland cement, tons	1816·3	6859·1	29,050·0	18,864·1
Sulphated blast furnace cement, tons	8372·0	9534·7	345·8	948·5
Man-hours (thousand)	1874	1450	2923	1654
Excavations, cubic metres	95,000	210,000	310,000	215,000

1958. These four sections were worked from their respective adits by different groups of contractors. Details of these arrangements and the main data of the tunnel construction are shown in Table II.

In view of the geological uncertainties, the use of a pilot tunnel was adopted in the first three sections, while at Birgl, where mostly limestone but also less favourable formations seemed likely to be encountered, it was decided to drive the full section.

As will be seen from Table II, the adits were sited so as to give a longer working length against the tunnel gradient and a shorter limb in the direction of the gradient, which improved drainage of the workings. To some extent the general line of the tunnel had to be shifted farther south into the mountain than would seem necessary from looking at the map, but this was necessitated by even less favourable rock conditions on the most direct route. A bad surprise was the high proportion—nearly one-quarter—of anhydrite which was encountered and which required the use on a large scale of super-sulphate blast-furnace cement (SH cement) for the tunnel lining. Altogether, including the penstock inlet where anhydrite was again met with, some 20,000 tons of SH cement were employed, until now the largest single application in Austria of this material.

Methods of supporting the roof varied according to conditions and so did the thickness and design of the lining. For immediate protection wide use was made of concrete placed by the "Torkret" process. The final lining varied in thickness between 25cm and 90cm and was of near-circular horse-shoe section with an internal diameter of 5·5m, representing a free area of 23·3 square metres. The heaviest sections were constructed in two layers, the 30m thick inner lining being reinforced over a full circle by round bars or wire mesh; the outer 35cm floor slab curved downwards with an outside radius of 6m, while the inner floor lining had a flat invert with a central gulley 1·30m wide by 40cm deep. The sand and mylonite section at the tunnel mouth, and various anhydrite sections, were specially reinforced in this manner, while the last 133m at the outlet were lined with 15mm thick steel penstock sections of 4m to 10m length with movable caulked joints. A telephone and a control cable are installed.

The invert level of the tunnel varies from 730·2m at the intake to 708m at the outlet into the storage reservoir, with a fall of between 1 in 670 and 1 in 2000.

In spite of the difficulties referred to, construction proceeded without a major hitch except for one serious inflow of thermal water at an initial rate of 700 litres per second in the Lend section, which for some time brought work to a standstill.

In view of the differences in the strata, no direct comparisons are possible between the different methods of tunnelling employed. It appears, however, that the quantity of explosive was rather higher where the full section was excavated.

STORAGE RESERVOIR

For daily storage, a reservoir was provided between the end of the diversion tunnel and the power station. This reservoir was sited in a saddle with a natural slope to the south, and outcropping rock to the north, the eastern and western sides being closed by earth embankments (Fig. 7). In this way an oblong basin of 1·5hm³ useful capacity was created with maximum and minimum water levels at 738m and 715m sea level respectively. In the depression at the western end is the outlet of the diversion tunnel and the scour culvert at 708·5m and 706m; at a corresponding depression at the eastern end is the penstock intake at 705m.

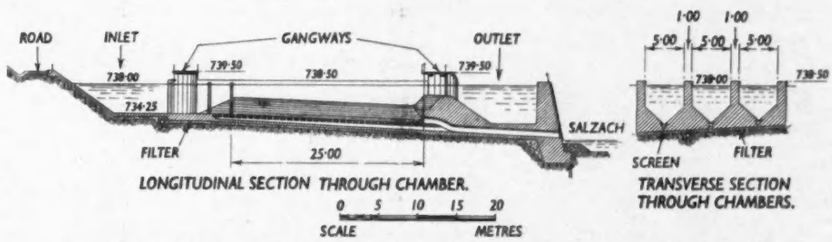


Fig. 6—Sectional views of fifteen-chamber device for removing sand from the diverted water

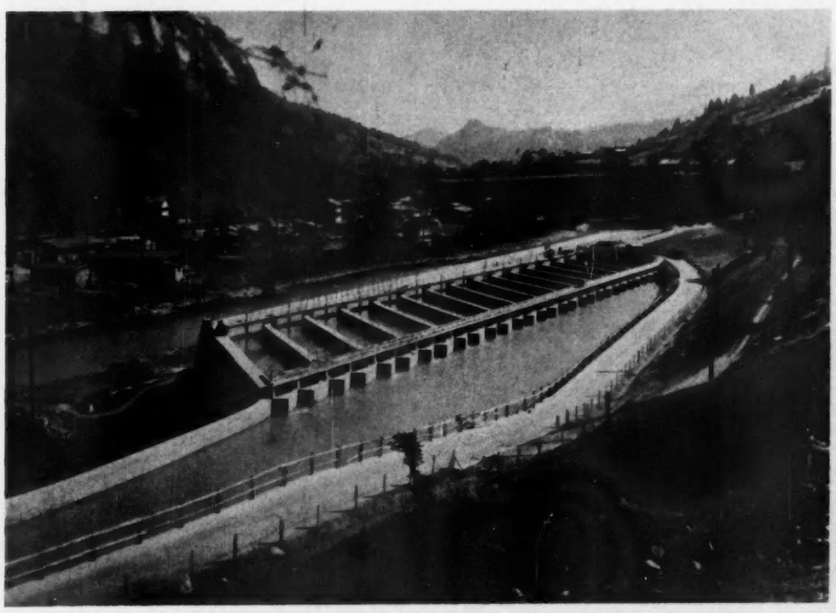


Fig. 5—Sand removal channels near the inlet of the diversion tunnel

The basin was mechanically excavated over the bottom area and southern slope to within 0·5m of the foundation level, the last layer being excavated by hand for greater accuracy. Some 1,200,000 cubic metres were excavated, relieving the formation of an average pressure of about 24 tons per square metre. The maximum head of water imposed subsequently varies according to position between 33m and about 23m.

Some 70,000 cubic metres of the firmer components (clayey gravels) of the excavated material were used for the banks, which were built up in layers 30cm to 40cm thick which were consolidated with vibrating rollers.

The design was based on contemporary German work, notably the Henne and Genkeltal dams and the Reisach-Rabenleite pumped storage reservoir. Water-tightness was obtained by an asphalt lining placed on a drained foundation layer. Next to the imperviousness of the surface, the success of the design depends upon the effectiveness of this drainage.

Along the bottom perimeter a concrete conduit was installed by the cut-and-cover method into which all drainage and local springs were collected. This conduit also provides access for inspection. The reservoir bottom was lined by a 60cm layer of packed rock placed upon a 25cm thick three-layer filter (40mm–80mm, 10mm–40mm, and 3mm–10mm grain size) to prevent ingress of fines. The two bank slopes and the southern hillside were covered in a similar way with a filter layer which was held in place by spiked-down wire netting. On this layer was placed a rock packing tapering from 60cm at the bottom to 30cm at the top. The rock surface in the northern sector consisted of strongly weathered and crushed limestone phyllite but was sufficiently watertight. The bad condition of the rock surface rendered it necessary to conserve it by

CONTINENTAL AFFAIRS *(Continued)*

Fig. 7—Hillside reservoir with a useful storage capacity of 1·5 cubic hectometres, seen from the south

spraying on a 10cm thick layer of concrete containing about 500 kg Portland cement per cubic metre, which was mesh-reinforced in steep places, and replaced by concrete slabs in those situations where the rock was altogether too brittle.

The waterproof lining consisted of two 6cm layers of asphalt placed on a bituminous intermediate layer applied purely for purposes of levelling the rock surface. The asphalt was placed at 180 deg. Cent. and rolled at temperatures not less than 140 deg. Cent. The usually porous edges of successive strips were hacked back and the surface painted with bitumen and heated with propane burners before applying the next strip. The upper asphalt layer was placed on the dry and dust-free surface of the under layer which when necessary was sprayed with bitumen to bind dust.

Connections with concrete structures were made by 0·4mm thick copper sheet which was lapped and sealed hot. These structures included the inlet and outlet, the scour culvert, and the breakwater/retaining wall around the rim.

The first filling was carried out in stages over twelve days, and after maintaining it for a fortnight, daily operation of the reservoir was commenced. Settlement was checked by means of a water tube level inside the peripheral inspection tunnel and the maximum deformation found was 28mm

Penstock

From the concrete outlet structure of the reservoir, a steel penstock of 5·2m internal diameter leads to an upper valve chamber fitted with a vertical lift gate valve of 4·4m by 4·4m section. From there it continues, at first horizontally and then dipping at 1 in 4, to a point at 592·6m level, 813m from the intake, tapering to 4·7m internal diameter. Continuing horizontally, the penstock bifurcates before entering the lower valve chamber, which contains separate control valves for each 3·3m diameter branch. As far as this point the penstock is embedded in concrete. The two branches run on in the open horizontally for about 120m where they split up into four strands of 2·2m inside diameter, turned through a 50 deg. angle before reaching the turbines.

The long straight open run from the lower valve chamber, unavoidable as it is owing to the conditions at the site, is a weak point of the layout, as the smaller branches, built into the turbine concrete, would be overstrained by temperature and dynamic movement in the larger pipes. To avoid this danger and also to allow for possible settlement of the power house foundation, special sections were incorporated in each pipe. These take the form of a pair of stuffing boxes held together by sets of ties arranged gimbal fashion so as to give freedom of movement both in the horizontal and vertical direction.

Owing to their diameter exceeding the loading gauge of the Austrian railways, the penstock sections had to be delivered in halves and welded at the site. The material was killed, low carbon steel "Aldur 35," "44," and "47," in thicknesses from 15mm to 27mm, and, in places, 40mm. After fabrication, the penstock sections were welded together inside the tunnel, the welds being tested with ultrasonic and X-rays. The concrete backing, itself backed by grouting after complete shrinkage, varied in thickness from 30cm to 40cm, reaching 60cm where access by the welders required it.

All three valves in the penstock are oil operated and arranged for quick shut-down in case of penstock failure. The maximum design flow rate is 107 cubic metres per second.

Power House

The Schwarzach power house (Fig. 8) stands on firm gravels and conglomerates on the right bank of the river Salzach, at river kilometre 135, on a flood-protected site at 596m level. The building rests on a heavy foundation slab divided by expansion joints into three sections, two of which carry the four turbine sets,

The turbine and generator of each set are supported on the foundation concrete and separated from the reinforced concrete of the hall floor by a 2cm wide gap which avoids transmitting vibrations to the building. Of the total enclosed volume, the 13·9m by 70·4m machine hall occupies 12,900 cubic metres, while a three-storey wing of 7200 cubic metres at the northern end houses the control room and switchgear, and the southern wing of 5300 cubic metres is occupied by the workshop and stores. A steel frame construction was employed for the building to facilitate erection during the winter. The hall is served by two 50-ton/10-ton cranes. The stilling basin is 40m wide, with up to 13m high sides, and continues into the 200m-long tailrace to the Salzach. The principal construction quantities may be seen from Table III.

Table III—*Principal Constructional Quantities of Schwarzach Power Station*

Total man-hours	$17{\cdot}3\times10^6$
Electricity consumption, GWh	48
Steel, tonnes	5170
Portland cement, tonnes	114,600
Super sulphate cement, tonnes	19,995
Timber (props and sawn), cubic metres	30,400
Diesel fuel, litres	$3{\cdot}9\times10^6$
Excavations :	
Tunnel, cubic metres	$0{\cdot}83\times10^6$
Storage basin, cubic metres	$1{\cdot}2\times10^6$

Turbines

The four vertical Francis turbines have a nominal capacity of 42,000 h.p. at a mean head of 132m and a flow of 26·6 cubic metres per second. Three of the turbines were supplied by J. M. Voith G.m.b.H., Heidenheim/Brenz, with welded spirals, while the fourth, by Franco Tosi, Legnano, has a cast spiral. Other differences exist with respect to the arrangement of the bearings and the manner of actuating the guide vanes. The machines operate at 375

Fig. 8—Schwarzach power station with river Salzach behind

r.p.m., with a runaway speed of 715 r.p.m., at a maximum station head of 148m.

The turbine control is designed so as to enable the initial semi-automatic operation to be converted later to a fully automatic one. For sudden shedding of respectively 25, 50 and 100 per cent of the load, a temporary speed fluctuation of +10, +18, and +33 per cent of full speed was specified. Maximum rise in the penstock pressure on complete load shedding was not to exceed 12 per cent of the static head.

For operating the generators as synchronous condensers, and for other purposes, the turbine chambers can be emptied by introducing compressed air.

Generators and Transformers

The generators, supplied by Elin A.G., Weiz, are laid out for 35MVA, 10·25kV ±7·5 per cent, 50 c/s, at cos ϕ=0·9. The total weight of each of these directly driven machines is 167 tons, of which the rotor and shaft account for 88·7 tons. At runaway speed the circumferential speed of the rotor, which has a diameter of 4150mm, is 558km per hour; each pole piece weighing 2095 kg is then subjected to a centrifugal force of 2160 tons.

Radial cooling fans are fitted on either side of the rotor, the lower one being combined with a disc brake which can stop the generator from half speed in about two minutes. The six brake cylinders also serve to lift the set for maintenance of the turbine thrust bearing. The two radial generator bearings are self-lubricating.

Each pair of generators is connected to the primary side of one transformer laid out for 2×35MVA, 10·25/116·5kV. The transformers were supplied by Elin A.G., Weiz, and Siemens-Schuckertwerke G.m.b.H., Vienna.

Operation

Four independent modes of operation are provided, viz., hand control with protective interlock, automatic operation, unlocked hand operation in case of failure of the automatic or interlocked controls, and emergency automatic stop. The operational state of the plant is shown on sets of identical diagrammatic panels in the control room and machine hall.

Most of the generated power is transmitted at 110kV to Kaprun where it is stepped up and fed into the 220kV grid. Any surplus power can be employed for pumped storage at Kaprun. The remainder is transmitted eastward to the Arthur Werk power station near St. Johann im Pongau and Vienna, at 110kV.

Backing-off Machine

The accompanying illustration shows an automatic backing-off machine produced by J. E. Reinecker Maschinenbau G.m.b.H., Einsingen near Ulm/Donau, German Federal Republic. The machine is handled in the United Kingdom by Stuart Davis, Ltd., Much Park Street, Coventry, and is intended as a high production machine for the accurate generation of the clearance angle on such components as hobs and thread cutting and milling tools. The workpieces can have straight or helical flutes, and radial or angular relieving can be carried out.

The cutting tool is carried on a crank-driven ram suspended by tension springs so as to counterbalance the weight. A pole-changing motor drives the cutting mechanism by means of vee-belts, the ram head slide being controlled by a cam to generate the correct clearance angle. The cross feed of the tool is achieved either manually or automatically.

The workpiece, which can be up to 11in in diameter, is held between two supports on an arbor, one end of which fits the No. 5 Morse taper socket of the work spindle. The latter is hardened, ground, and lapped on the journals which run in adjustable bronze bushes.

For obtaining the longitudinal feed (maximum 20in) the work headstock can be traversed by means of a two-speed handwheel, or by the automatic power traverse. The automatic traverse is also employed for producing helical cutters. For this purpose it is equipped with a precision lead screw with double nut so as to eliminate backlash. The work headstock incorporates the drive motor, a rapid return device, reduction gearing, a "Corex" duplex worm drive compensated for backlash for the work spindle, change gears for thread pitches, chip flutes, and chip flute spiral leads.

Within the machine bed are situated the hydraulic controls and the pump unit.

The maximum backing-off stroke is 0·875in, and the greatest plunging depth, 1in. The plunging speed can be varied between zero and 20ft per minute. From two to forty teeth can be backed off, covering a range of diametral pitch of from 50 to ½, and spiral flute pitches of from 8in to 360in. For backing-off parts which do not require to be ground after hardening, the machine can be set to take a finishing cut automatically after all the teeth have been rough-machined.

Testing Equipment for Cylindrical Components

In the accompanying illustration we show an instrument for measuring the roundness, parallelism and straightness of cylindrical components, recently introduced by Hommelwerke G.m.b.H., Mannheim/Käfertal, and handled in this country by Rubert and Co., Ltd., Acru Works, Demmings Road, Councillor Lane, Cheadle, Cheshire. Developed in conjunction with Dr. Perthen of Hanover, the equipment is designed to provide, by measurements with the same stylus, a complete three-dimensional description of the test piece. The range of measurement is 3mm bore to 150mm outside diameter and a vertical height of up to 200mm, with a magnification of 10,000 times. There are four principal parts, i.e. the mechanical testing apparatus, the graph recorder, the control equipment, and the viewing equipment.

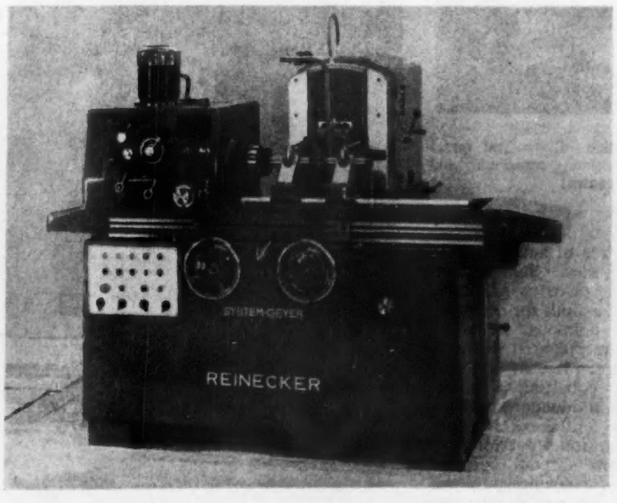
The mechanical tester consists of a high-precision turntable with centring clamps for preliminary centring, and the column-mounted electrical tracer. Besides the preliminary centring, no further adjustment is necessary, as the fine adjustment is carried out automatically. The electrical tracer is mounted on a slide which moves on a vertical column; the latter is finished to a high degree of precision so as to provide an accurate datum for the measurements. The column can be moved horizontally in order to provide a rough adjustment to the diameter of the specimen; the fine adjustment is again automatic. For operating the turntable, two speeds are provided, viz. 5 and 10 r.p.m.

The recording equipment, seen on the left in the illustration, comprises a polar recorder for recording errors of roundness with a radial magnification of up to 10,000, and a recorder for measuring parallelism and vertical errors of form. Both recorders are electrically connected to the tracer system, the ratio of their magnifications being 1 : 1, 1 : 2, or 2 : 1. There are seven measuring ranges from ±2 to ±200 microns, with magnifications varying inversely as the range from 10,000 to 100 times.

The control equipment, on the lower shelf of the table on the left, provides fully automatic centring which can be observed on a cathode ray tube which also gives a polar image of the roundness error.

Automatic Bundling of Bars

In most mills, bars are still bundled by hand. This procedure, especially in merchant mills of high productive capacity, requires extensive equipment and many bundling operators. Schloemann Aktiengesellschaft, Düsseldorf, Steinstrasse 13, has developed a machine which enables the bundling of bars to be carried out fully automatically. The machine bundles bars into packages from 50 kg to 300 kg. It is possible to vary the bundle diameter and length of bar within given limits. The material to be bundled is entered between two arms, which carry the tying wire. It is therefore unnecessary for the wire to be placed around the bars before completing the bundle. Bundling the bars, twisting the wire, and cutting off the finished bundle is carried out in quick succession, each operation partly overlapping the next.



Backing-off machine for the automatic production of straight and spiral cutters and hobs

Testing and recording equipment for cylindrical components

THE AMERICAN SCENE

by Our American Editor

Expanded Standard Materials Programme at the N.B.S.

The National Bureau of Standards is now distributing 60,000 samples of standard materials a year to other laboratories for use in controlling chemical processes and in maintaining the accuracy of apparatus and equipment. A total of over 600 different materials are available from the Bureau—principally chemicals, ceramics, metals, ores, and radioactive nuclides. These standards make possible uniform measurements of heat and temperature, define the colours of paints, and calibrate instruments that control the composition of metals and motor fuels.

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Within the past five years, requests from American science and industry have resulted in the issue of about seventy new standard materials. Meanwhile, 150 new standard materials are being prepared for issue through various programmes of analysis and precise measurement. Much of this expansion in the standard samples programme has resulted from current efforts by government and industry to develop materials having specific properties for use at high temperatures or under other extreme conditions.

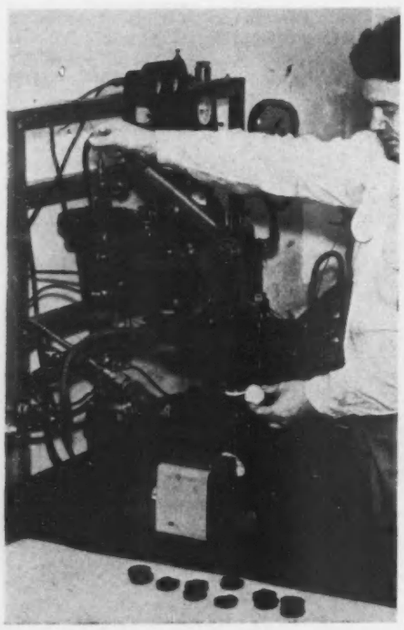


Fig. 1—Use of Mooney viscometer to determine vulcanisation characteristics of solid rubber test components

Chemical Standard Samples

The standard samples programme was established in 1905 when the American Foundrymen's Association turned over to the Bureau four sets of cast iron to be standardised for chemical composition. The majority of these chemical standards are metals and alloys, used extensively for monitoring the thousands of analyses made daily in industrial laboratories. Standards of chemical composition also serve as guides in developing new analytical methods for determining the composition of unknown materials. New chemical standards are prepared whenever an industrial need develops. Recent additions include high-temperature cobalt-nickel alloys for jet engine and missile production, titanium alloys for aircraft and ordnance research, zirconium alloys for nuclear power development, lithium ores for the new lithium chemical industry, lead-tin bronzes for defence purposes, and Portland cement for the cement manufacturers.

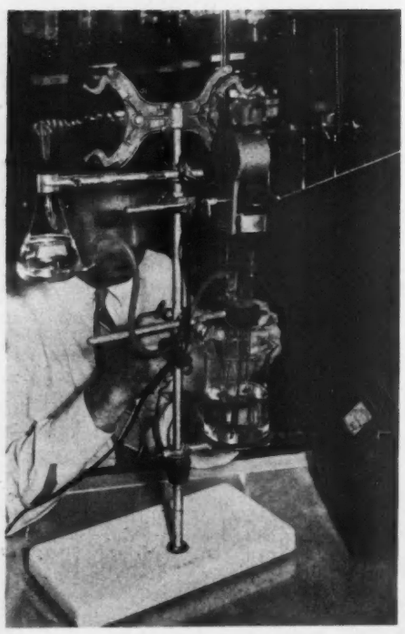


Fig. 2—Potentiometric titration of standard metal sample to determine chromium, vanadium and manganese content

About 200 samples of hydrocarbons are issued as " pure substances " and certified with respect to their degree of purity of 99·99 per cent. This category was initiated to fill the gap for standards needed to calibrate instruments, particularly mass spectrometers, employed in controlling the production of synthetic rubber and of special fuels for military aviation. These samples may also find application as gas chromatographic standards. As one of this group, a halogenated hydrocarbon—bromobenzene—is being purified. This compound will be particularly useful in the rubber industry. In connection with the hydrocarbon programme, a new group of standard samples is being developed. Each of these standards will be a mixture of pure hydrocarbons rather than one pure compound and will be used mainly for checking petroleum fractions. At present, eight such mixtures are under consideration.

A new set of metal standard samples comprises seven types of steels whose oxygen and nitrogen content have been carefully determined. These reference materials are necessary for the calibration of analytical equipment used to determine the gaseous elements in various kinds of commercial steels. Low gas content is a characteristic of metals with desirable properties, and the acceptable amount of gases present in a metal may be expected to be stipulated in procurement specifications for metals and metals products in the future. With the certification of these standards, the Bureau has begun a programme for producing gases-in-metals standards for a number of metallurgical products. Work is now in process to develop standard samples certified for the content of oxygen and hydrogen in titanium alloys.

Spectroscopic Standard Samples

High-speed spectrochemical methods of analysis have been extensively adopted in recent years by both producers and consumers

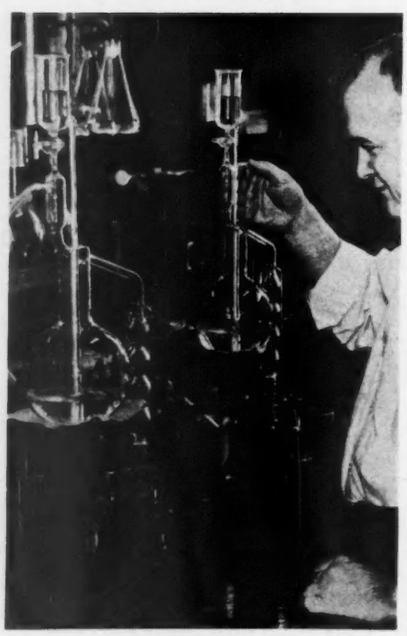


Fig. 3—Distillation of standard metal sample solution to determine antimony, arsenic and tin content

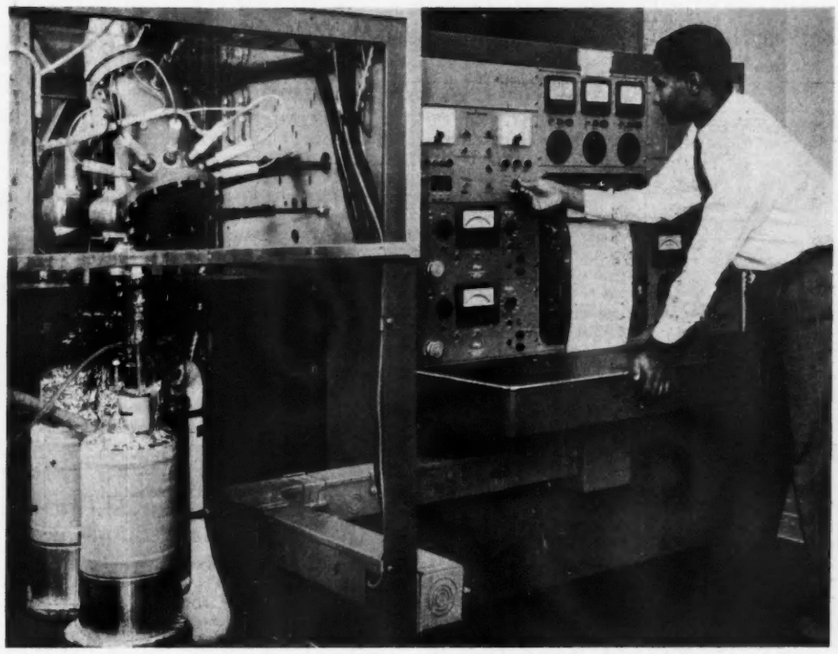


Fig. 4—Use of surface ionisation mass spectrometer to determine the minor isotopic abundances of uranium standards

of metal products. These methods are essentially comparison techniques in which the spectra from unknown samples are referred to the spectra from samples of known composition. Thus, standard samples play a basic part in spectro-chemical analysis.

The first spectroscopic samples were developed during the last war in response to a need for standards for high-speed control analysis in steel production and inspection. To date, about 120 of the composition standards have been specifically produced for spectroscopic use. Metals and alloys for forty-four new spectroscopic standards have been prepared and are now being analysed for content and tested for homogeneity by the Bureau, while final plans have been made for sixty-six others yet to be prepared.

About three years ago, after studying industrial and governmental needs, the Bureau started a greatly expanded programme on spectroscopic samples. This programme is designed not only to satisfy the basic requirements of industry for such common materials as cast iron, steel and copper-base alloys, but also to provide standards of newer materials, such as high-temperature alloys, titanium alloys and zirconium alloys. The former two are finding application in the aircraft and missile industrial fields and the latter in atomic energy installations. Four corrosion-resistant, high-temperature standards (19-9DL, AMS 5360A(AISI 316), AMS 5376A (N-155), and Nimonic 80A) and three titanium standards are now available, while a total of eighteen other high-temperature standards and six zirconium-base standards will be certified in the near future.

To improve specific physical properties of metallurgical alloys, minute amounts of certain elements are added. Thus the heat-resistant alloys used in rockets and jet engines contain various combinations of boron, tungsten, molybdenum, titanium, zirconium, niobium, tantalum and aluminium as well as the major metals. Because of the complex composition of these materials and difficulties in chemical analysis, spectrographic and X-ray methods are used to control their quality in production. The Bureau has been preparing standards which are certified for trace elements as well as major constituents. For instance, in a set of eight ingot iron and low-alloy steels recently prepared seventeen elements are included in provisional certificates of analysis, and six more are under study for further certification. Another example is the new set of zirconium standards which is being developed primarily for application in the atomic energy field. Some thirty elements are under investigation in this set, many at the parts-per-million level.

The field of X-ray fluorescence has become increasingly important for rapid analysis. Like optical-emission instrumentation, these newer X-ray instruments require standard samples for their calibration. The Bureau recognised this need several years ago and many spectroscopic standards which are now available or in preparation are designed for X-ray fluorescence analysis. To date, fourteen standard samples have been developed specifically for X-ray fluorescence, while twelve standards are equally suitable for both methods of analysis.

Radioactive Standard Samples

Since 1913, when the United States received its first national radium standard (Radium-6), much of the radium produced or sold in this country has been calibrated against this standard by the Bureau. With the production of radioactive materials in the 1930s, the need for radioactivity standards of elements other than radium has steadily increased, and has been accelerated by the discovery of controlled nuclear fission. For radiation safety, for planning experiments, and for ordering and disposing of active material, a knowledge of the disintegration rate of the specimen is essential. Hence, the total efficiencies of the various radiation detectors under differing experimental conditions must be accurately determined by calibration against radioactive samples.

To-day, the Bureau distributes standard samples of forty different types of radioactive nuclides. These standards are used for the calibration of equipment which in turn are used in the measurement of the same types of nuclides. These nuclides have widely varying applications. Several are used medically in the treatment of such ailments as leukemia (phosphorus-32) and cancer (gold-98), as well as in the study of blood formation (iodine-131) and metabolism (carbon-14). Cobalt-60 is used in the engineering industry to check flaws in castings or shell casing. Other nuclides are used to determine such factors as contamination of food crops by strontium-90 and the age of wine and liquors as indicated by the amount of tritiated water present. Standard samples of mercury-203, niobium-95 and strontium-85 have been made available, while ten other point-source standards, including sodium-22 and zinc-65, are now being prepared.

Uranium Standards

The considerable expansion in the application of uranium and related atomic energy materials in recent years has emphasised the need of uniform standards which will be widely accepted for standardising materials and calibrating instruments. Although various A.E.C. laboratories and contractors have developed standard materials for their own use, a central set of standards was needed.

To meet this demand, the Bureau issues a series of fifteen isotopic standards in co-operation with the U.S. Atomic Energy Commission. This set, which is used by educational and research institutions and industries both in the United States and abroad, contains a graduated series of standard samples ranging from uranium depleted in U^{235} (containing 0·5 per cent U^{235}) to a highly enriched material containing 93 per cent U^{235}. The selection of the composition of the intermediate samples was made upon consultation with an advisory committee set up by the A.E.C. These standards of uranium enable laboratories to evaluate their own reference materials. In addition to the isotopic range, a natural uranium standard is included in the series. This standard is often used directly as a working standard or control material in experiments. The programme is being expanded to include standards for other atomic energy materials such as plutonium and thorium.

Nuclear Reactor for Biological Research

An unusual nuclear reactor with two radiation faces, to be used exclusively for biological research, will be built at the Argonne National Laboratory, Lemont, Illinois. The reactor will be named "Janus," after the two-faced Roman god, and will be used to study the effects of both high and low doses of fission neutrons in small animals. It is expected to be ready for operation in early 1961 and is estimated to cost 560,000 dollars.

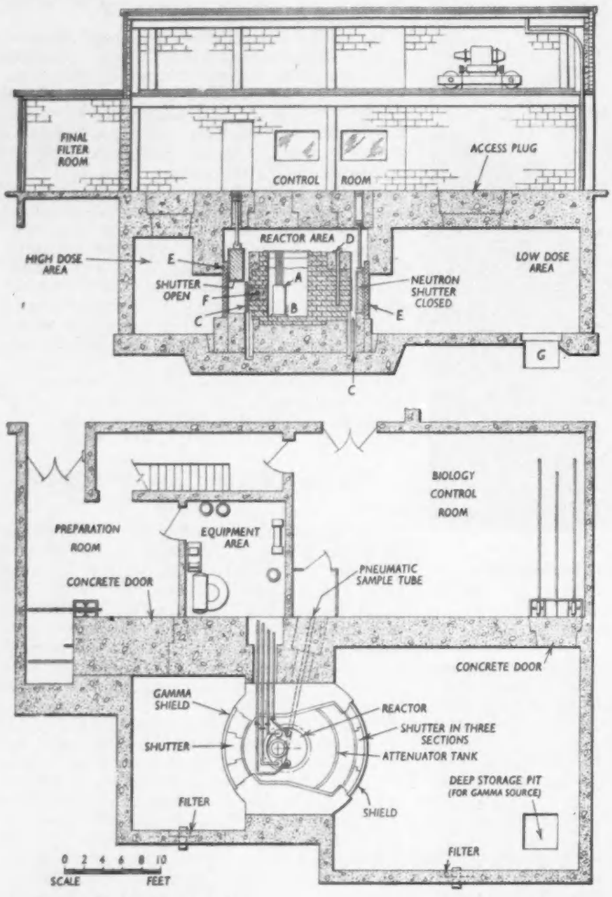
The reactor will be used for studies of the effects of exposing small mammals and other biological specimens to neutrons at various levels of intensity over an extremely wide time range. For a number of years, in co-operation with other A.E.C. facilities, the Biological and Medical Research Division of Argonne has been investigating early and late effects of radiations in mammals given in widely differing patterns and dose rates. The division has two specially-constructed rooms where mammals are exposed to high and low levels of gamma radiation from cobalt-60 sources. Work with fission neutrons by Argonne was first carried on at the laboratory's early research reactor, CP-3. When the laboratory built the Argonne Heavy Water Research Reactor CP-5 in 1954, a special radiation chamber was installed to allow neutron irradiation of biological specimens.

The neutron biology work at Argonne has centred on essentially three problems: (*a*) the differences in time and cause of death following neutron and gamma irradiation; (*b*) deviations in additivity of neutron and gamma radiation in inducing acute lethality; and (*c*) the differences in recovery rate following neutron and gamma irradiation. The new reactor will make it possible to carry out, simultaneously, experiments at much higher and lower neutron dose rates than previously has been possible. This will permit a complete evaluation of relative biological effectiveness and of the basic nature of injury and recovery processes. Furthermore, it will be possible to complement the present studies of gamma ray effects with low dose and low dose rate neutron studies. It will also be possible to extend the studies of fission neutron exposure to larger species.

The reactor will be a tank-type heterogeneous reactor, i.e. the fissionable fuel (enriched uranium) and the material used to moderate the fission neutrons (ordinary light water) will be arranged as discrete separate bodies. Nineteen assemblies containing a total of 6·6 lb of uranium-235 will form a fuel core 16in in diameter. The uranium-bearing portion of this core will be about 26in long. Installed in an aluminium tank, the core will be completely surrounded by water to moderate the fission neutrons and to cool the reactor.

The fuel core of "Janus" will be situated slightly off centre in the reactor tank to provide

THE AMERICAN SCENE *(Continued)*



A—Fuel core, nineteen fuel assemblies.
B—Pneumatic sample tube.
C—Converter plates, 1in thick uranium.
D—Attenuator tank on low dose side, 4ft by 10ft by 4in.
E—Lead gamma shields, 6in thick on high dose side, 4in thick on low dose side.
F—16in square hole in thermal column on high dose side normally packed with graphite.
G—Storage pit, 3ft deep (location for gamma source, if needed).

Elevation and plan of the "Janus" reactor

different intensities of fission neutrons in the two irradiation rooms. The tank itself will be approximately 4ft in diameter and 7ft high. It will be made of ¼in thick aluminium. The tank will be sealed gas-tight by a gasketed cover. Ordinary water will circulate upward in the tank through the fuel assemblies and then through a heat exchanger. A portion of the water will be constantly circulated through an ion exchange column to remove impurities. To reflect escaping neutrons back into the reactor, a layer of graphite ranging from 1ft to 5ft in thickness will be built around the tank. With the exception of its two radiation faces, the reactor will be heavily shielded by dense concrete. The fuel assemblies will be similar to those employed in the Argonne Heavy Water Research Reactor CP-5. Each will be 3in in diameter and will consist of enriched uranium encased in three concentric aluminium tubes.

So that the reactor can be operated for as long as three years without a reloading of nuclear fuel, more enriched uranium will be built into the fuel assemblies than will be necessary to run the reactor at its rated power. To keep down the rate of fuel consumption, strips of boron-aluminium will be placed inside each fuel element to stop excess neutrons. These strips will be removed as the uranium fuel is used up. The high-dose irradiation room will be 16ft long, 12ft wide and 8ft high. A convex radiation face, approximately 3ft high and 6ft 6in wide, will allow neutrons to escape from the reactor into the room. The distance from the centre of the fuel core to the face opening will be approximately 5ft. A movable converter plate of 1in thick uranium placed over the high-dose face will raise the energies of neutrons produced in the reactor from relatively low (or "thermal") to high (or "fast") velocities.

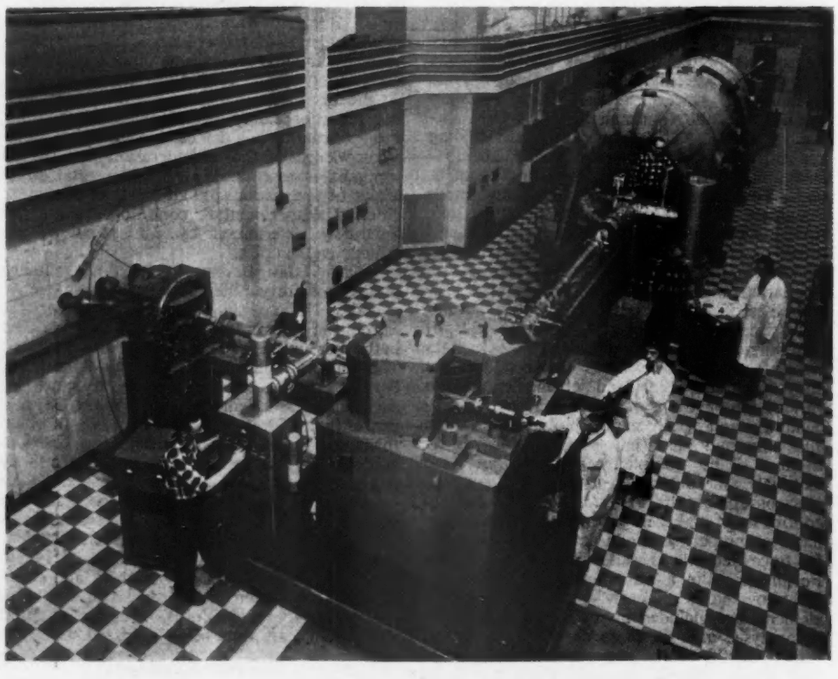
To prevent radiation from coming into the room, a 20in thick shielding shutter can be lowered in front of the high-dose face. The shutter will be operated in three independent sections, so that only a portion of the neutron beam can be allowed to escape from the reactor. When all three sections of the shutter are in place, the uranium converter plate will be removed to further cut down radiation from the reactor. A lead gamma shield, 6in thick, will be installed across the high-dose radiation face in front of the shutter. On the high-dose face a 16in square hole will pierce the graphite thermal column of the reactor. Available for special-purpose irradiations, this hole will normally be packed with graphite.

The low-dose irradiation room will be 26ft long, 24ft wide and 11ft high. A larger convex radiation face, approximately 3ft high and 10ft 6in wide, will allow neutrons to escape from the reactor into the low-level room. The distance from the centre of the fuel core to the low-dose face opening will be about 7ft. A movable 1in thick uranium converter plate will also be placed over the low-dose face. The room will have a 10in thick shielding shutter, also operated in three independent sections. When all three sections are in place, the converter plate will be removed. A 4in thick lead gamma shield will be held in place across the face in front of the shutter. An aluminium tank, 4ft high, 10ft wide and 4in deep, will be installed on the low-dose side of the reactor. The tank has been designed so that it can be filled with a boric acid-water solution to attenuate the neutron beam, should this be necessary.

12 MeV Tandem Van de Graaff Particle Accelerators

THE U.S. Atomic Energy Commission has ordered three 12 MeV tandem Van de Graaff particle accelerators from the High Voltage Engineering Corporation, of Burlington, Massachusetts. The machines will be used for basic physics research at the Argonne National Laboratory, Lemont, Illinois; the Oak Ridge National Laboratory, Oak Ridge, Tennessee, and the nuclear physics department of the Rice Institute, Houston, Texas. The new research accelerators are the largest and most powerful of their type and more than double the useful range of previous electrostatic accelerators. They are capable of accelerating protons to 12 MeV and heavy positive ions to acceleration energies in the 40–60 MeV range, and will permit investigations of heavier nuclei which cannot be studied with lower energy machines.

The tandem accelerator comprises two 6 MeV Van de Graaff acceleration columns: a steel pressure vessel, 8ft in diameter and 34ft long, encloses the entire unit, which weighs more than 35 tons. The first accelerator of this advanced two-stage design was installed at the Chalk River, Ontario, laboratories of Atomic Energy of Canada, Ltd., where it is facilitating precision nuclear research in areas heretofore unexplored.



12 MeV tandem Van de Graaff particle accelerator made up of two 6 MeV machines

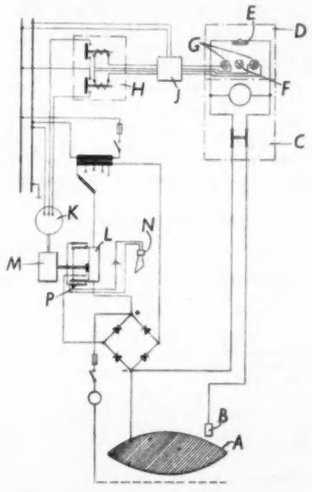
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

ELECTRICAL ENGINEERING

826,824. April 24, 1958.—PREVENTION OF ELECTROLYTIC CORROSION ON SHIPS, Veb Mathias-Thesen-Werft, Wismar, Germany. (*Inventors: Johannes Fischer, Otto Stuhlert, Alois Olbrich, Willi Wiegand, Otto Wilde, Karl Schubart and Rudolf Smudel.*)

Causes of electrolytic corrosion of the hulls of ships while being fitted out include so-called "stray" currents, which are conveyed to the hull by defective welding cables or welding machines, or other faulty current-supply cables. Such currents return from the wall of the ship to the current generator by some path other than that provided for, and have been shown by experience to cause corrosion to the underwater part of the ship to a far greater extent, and in a far shorter time, than the usual influences. The present invention takes into account the fluctuating ship's potential influenced by different welding



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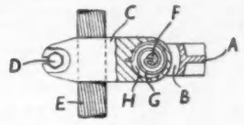
currents and the like, in that the counteracting potential necessary at any time is automatically regulated. In the embodiment illustrated, the natural potential of the hull *A* of the ship obtaining at any time is measured between the copper-copper sulphate electrode *B* and the said hull and is indicated by a recording millivoltmeter *C* and constantly recorded. At the same time, this measurement value is sent as a regulating value to the regulator *D*. If this regulating value differs from the prescribed protective potential (830–850mV), either in an upward or downward direction, the rotating mirror *E* is swung from its normal position and directs a light beam from the incandescent lamp *F* to the photoelectric cell *G* for movement to the left or right. By this means, the relay arrangement *H* receives a corresponding current impulse through the photoelectric cell amplifier *J*. The corresponding relay now actuates the motor *K* for movement to the right or left, so that the variable resistance *L* of the compensation current circuit is limited or increased by the gearing *M* so that the required protective potential is maintained. If resistance *L* is driven to its upper or lower position a warning device such as hooter *N* may be operated through contacts *P*.—*January* 20, 1960.

827,743. June 14, 1956.—CABLE SPACERS FOR MULTI-CONDUCTOR, OVERHEAD TRANSMISSION LINES, Metalastik, Ltd., Evington Valley Road, Leicester and Watshams, Ltd., Oxford Street Chambers, 16, Oxford Road, Reading, Berkshire. (*Inventor: Horovitz and Fred Kay.*)

An object of this invention is to reduce or eliminate wear and to dispense with the need for lubrication in spacers for overhead lines. Referring to the drawing, the cable spacer comprises a link or rod *A* having, at each end, forked arms *B*. Hinged to each forked end of the link or rod is a two-part clamp *C*. The two parts of the clamp are hinged together (not shown), and there is a nut and bolt device *D* to draw them together. The clamp parts define between them a circular opening to receive a cable *E* and by tightening the nut the clamp grips the cable. When the cables joined by the cable spacer are substantially in a horizontal plane it is arranged that each clamp *C* is pivotally secured to the link by a bolt *F* which is secured fast to the link. The bolt is substantially vertical and is secured to the forked ends of the link. The cables to be joined may be in a vertical plane, the bolts then being horizontal. However, a horizontal arrangement of the cables will be assumed in the following description. A spiral (clockwork) metal spring *G* is provided for each limb of each fork, the inner end of each



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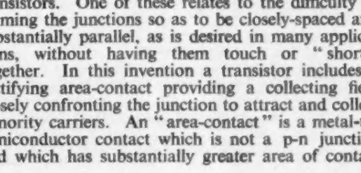
spring being anchored to the bolt *F* and the outer end of the spring being anchored to the clamp *C*, the spring lying in a pocket *H* within the clamp. The metal spring joints between the clamps and the link permit angular movement of the clamps relatively to the link in a horizontal plane. A considerable relative lengthwise movement of the pair of cables which are joined together is thus permitted while ensuring that the cables are held apart by a minimum amount. Low amplitude vibration in both conductors, which is one of the main causes of wear at the joints of cable spacers as at present made, is effectively catered for by the spring joints and such vibration is damped out by the springs. Since movement of the cables is provided for by deflection of the metal springs and there is no rubbing engagement of the parts of the joints it is unnecessary to lubricate the joints. The resistance of the springs to deflection assists in returning the cables to their undisplaced position. Three variations of this arrangement are also shown in the specification.—*February* 10, 1960.

ELECTRONICS

826,916. November 17, 1955.—SEMICONDUCTIVE SIGNAL-TRANSLATING DEVICES, Philco Corporation, Tioga and C Streets, Philadelphia, Pennsylvania, United States of America.

There are several inherent practical disadvantages in the common arrangements of opposing junctions in transistors. One of these relates to the difficulty of forming the junctions so as to be closely-spaced and substantially parallel, as is desired in many applications, without having them touch or "short" together. In this invention a transistor includes a rectifying area-contact providing a collecting field closely confronting the junction to attract and collect minority carriers. An "area-contact" is a metal-to-semiconductor contact which is not a p-n junction and which has substantially greater area of contact



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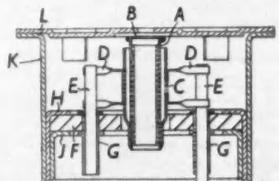
between the metal and semiconductor than a line contact or a point contact, and in which the metal is in intimate, substantially stressless engagement with the semiconductor. The junction and the rectifying area-contact closely confronting it may be utilised as the gate elements of a field effect transistor, or alternatively the two elements may be utilised as the emitter and collector elements of a bipolar transistor. With this construction, the rectifying area-contact may be spaced extremely accurately with respect to the junction and may be made substantially plane-parallel therewith, so as to obtain reproducibly transistors which are not only operative with excellent gain but which are also suitable for high frequency use, particularly in the case of the bipolar type. Referring to the drawings, the bipolar transistor there shown comprises a body of semiconductive material *A* having therein a junction *B*, typically formed by alloying into body *A* a suitable metal *C*. The junction may comprise a p-n junction of usual form, the metal *C* being chosen from a group comprising metallic activators of the type opposite to those in excess in body *A*. The junction *B* is closely spaced from the opposite surface of the body *A*, and in the present example this is accomplished by providing a depression *D* in body *A*, the bottom of which is closely spaced from the junction and conforms generally to its convex boundary. Upon this closely-spaced, opposing surface of body *A* there is provided a metal-to-semiconductor rectifying area-contact *E* between a body of suitable metal *F* and the semiconductive surface. Also provided are a base tab *G*, soldered to base *A*, and leads *H*, *J* and *K* making connection to the body of metal *C*, the base tab *G* and the metal body *F*, respectively.—*January* 27, 1960.

827,557. July 29, 1957.—CATHODES FOR ELECTRON GUNS OF CATHODE RAY TUBES, Pye, Ltd., Radio Works, St. Andrews Road, Cambridge. (*Inventor: William George Deboo.*)

Previous methods of holding the cathode in the electron gun of a cathode ray tube have involved securing it by substantial metal arms to the cathode connection on one side and to a support on the other side. Such methods have the disadvantage that there is considerable heat loss via these supports, and it is a more particular object of this invention to provide means whereby the cathode can be supported rigidly with materially less heat loss. In the embodiment illustrated the cathode is



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in the form of a tubular member *A* covered by an end cap *B*. Secured to its lower end, for example, by welding, is a metal cylinder *C* the inside of which is polished. The tube *C* is secured to rigid supports *D* which are carried by two posts *E* of conducting material, these posts in turn being supported in a disc of insulating material *F* by means of the eyeletted tubes *G*. The disc *F* is held in place between two flange plates *H* and *J* secured to the inner wall of a shell *K* forming the grid and the grid is terminated at its upper portion by a disc *L*. The shell *K* may be flanged at its upper and lower ends as shown. Details are also given of two embodiments in which the metal cylinder is integral with the cathode.—*February* 10, 1960.

RAILWAY EQUIPMENT

826,428. March 6, 1958.—RAIL-TRACK STOP DEVICE FOR HOLDING AND LOCATING WAGONS, Strachan and Henshaw, Ltd., Steelhoist Works, St. Philips, Bristol, 2. (*Inventor: George Wilfred Grossmith.*)

A rail-track stop device, according to this invention, comprises a chock member pivotally mounted on an axis which is horizontal and at right angles to the rail track. The chock is located adjacent to a rail to engage a wheel of a wagon. It has on its underside a cam surface and on its upper side a shoe-like surface adapted to co-operate with a wagon wheel when the chock is in an elevated position. A ram reciprocated longitudinally in respect to the rail track has a cam follower on its end adapted to co-operate with the cam on the bottom of the chock to raise and hold the chock in its operative position when the ram is at one end of its travel.—*January* 6, 1960.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, March 4.—LIVERPOOL AND DISTRICT BRANCH: Industrial Development Centre, M.A.N.W.E.B., Paradise Street, Liverpool, 1, "Town Distribution Network," 7.30 p.m.
Mon., March 7.—BOLTON BRANCH: Railway Hotel, Trinity Street, Bolton, "Protective Equipment for Industrial Plant," W. L. Stern, 7.45 p.m. ★ BOURNEMOUTH AND DISTRICT BRANCH: Grand Hotel, Firvale Road, Bournemouth, Lecturettes and "Quiz" by branch members, 8 p.m. ★ CENTRAL LONDON BRANCH: White Hall Hotel, Bloomsbury Square, London, W.C.1, "Electrical Contracting," J. Flood, 7.15 p.m. ★ LEEDS BRANCH: Great Northern Hotel, Leeds, "High Fidelity Sound," 7.30 p.m. ★ NORTH WEST LONDON BRANCH: Century Hotel, Wembley, A.S.E.E. Exhibition, Colour film, presented by P. A. Thorogood, 8.15 p.m.
Tues., March 8.—CHESTER AND DISTRICT BRANCH: Westminster Hotel, City Road, Chester, "Protective Equipment for Industrial Plant," W. L. Stern, 7.45 p.m. ★ GLASGOW BRANCH: Kenilworth Hotel, Queen's Street, Glasgow, "Modern Electric Railway Signalling," 8 p.m. ★ PORTSMOUTH AND DISTRICT BRANCH: Offices of the Ministry of Labour and National Service, Lake Road, Portsmouth, "Association Affairs," E. A. Bromfield, and Colour film of the 1959 Electrical Engineers (A.S.E.E.) Exhibition, 7.30 p.m. ★ YORK BRANCH: Georgian House, Blossom Street, York, "Infra Red and its Applications," K. Cruickshanks, 7.30 p.m.
Wed., March 9.—BIRMINGHAM BRANCH: Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "The Association," H. B. Mellor, 7.30 p.m. ★ SOUTH EAST LONDON BRANCH: Eltham Green School, Queenscroft Road, Eltham, S.E.9, "Cathode-Ray Tubes," C. H. Gardner, 7.45 p.m. ★ LUTON BRANCH: College of Technology, Park Square, Luton, "Application of Closed Circuit Television," 8.15 p.m.
Thurs., March 10.—BRADFORD AND DISTRICT BRANCH: Midland Hotel, Bradford, "H.F. Heating," A. B. Padget, 7.30 p.m.

BRITISH COMPUTER SOCIETY

Mon., March 7.—GLASGOW BRANCH: Royal College of Science and Technology, Glasgow, "Use of Computers in Operations Research," K. D. Tocher, 6.45 p.m.
Wed., March 9.—HULL BRANCH: Chamber of Commerce, Samman House, Bowlalley Lane, Hull, "Staff and Organisation of a Computer Department," K. Scott, 7.30 p.m.
Thurs., March 10.—BELFAST BRANCH: 29, University Square, Belfast, "Production Control," 7.15 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

To-day, March 4.—SOUTH MIDLANDS SECTION: North Gloucestershire Technical College, Cheltenham, "The Use of Radio Aids in the Control of Modern Transport Aircraft," K. Fearnside, 7 p.m.
Mon., March 7.—MERSEYSIDE SECTION: University Club, Liverpool, short informal papers by members, 7 p.m.
Tues., March 8.—WEST MIDLANDS SECTION: Matthew Boulton Technical College, Birmingham, "Transistor Power Amplifiers," F. Butler, 7.15 p.m.
Wed., March 9.—NORTH EASTERN SECTION: Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne, "Silicon Photo-Voltaic Cells in Instrumentation and Control," A. A. Shepherd, 6 p.m.

BRITISH INTERPLANETARY SOCIETY

Sat., March 5.—Lancaster Room, Caxton Hall, London, S.W.1, Symposium on "The Exploration of the Moon"; "Description of the Moon," P. Moore; "Unmanned Exploration of the Moon," K. W. Gatland, and "Manned Exploration of the Moon," W. N. Neat, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Thurs., March 10.—MANCHESTER CENTRE: Demonstration Theatre, Town Hall, Extension, Manchester, "Characteristics and Applications of Photo-Cells," F. A. Benson, 6 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Thurs., March 10.—LONDON BRANCH: Joint works visit with the Birmingham Branch to Ford's Imperial Foundry, Leamington, 8.30 a.m.

INSTITUTE OF FUEL

To-day, March 4.—SOUTH WALES SECTION: South Wales Electricity Board Showrooms, Kingsway, Swansea, "Steam Utilisation," D. P. Golch, 6 p.m.
Wed., March 9.—LONDON BRANCH: Institution of Civil Engineers, Great George Street, London, S.W.1, "Nuclear Power for Ship Propulsion," J. E. Richards, 5.30 p.m. ★ NORTH WESTERN SECTION: Engineers' Club, Albert Square, Manchester, 2, "Problems with the Use of High Sulphur Oil Fuels at Marchwood Power Station and Experience with Chemical Additives," T. J. Wilkinson and D. Clarke, 2.30 p.m.
Thurs., March 10.—MIDLAND SECTION: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "The Work of B.C.U.R.A.," D. T. A. Townend, 6.30 p.m.

INSTITUTE OF METAL FINISHING

Wed., March 9.—ORGANIC FINISHING GROUP: British Institute of Management, 80, Fetter Lane, London, E.C.4, "Inspection and Testing of Organic Finishes," R. J. Brown, 6.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., March 7.—SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, Elmbank Crescent, Glasgow, "Costs and Costing Relating to the Operation and Maintenance of a Fleet of Vehicles," W. J. Edbrooke, 7.30 p.m.
Wed., March 9.—SOUTHERN CENTRE: Palmeira Hotel, Hove, "Modern Trends in Paint Manufacture and Application," E. J. Robins, 7.30 p.m. ★ SOUTH EASTERN GROUP: Wig and Gown Hotel, Maidstone, "Diesel Power Units," D. Kalberry, 7.30 p.m. ★ EAST MIDLANDS CENTRE: Mechanics' Institute, Nottingham, "Brains Trust," 7.30 p.m.
Thurs., March 10.—NORTH REGIONAL CENTRE: Victoria and Station Hotel, Preston, "Materials Handling—Its Equipment and Maintenance," D. MacDonald-Walker, 7.30 p.m.
Fri., March 11.—SOUTH WALES CENTRE: South Wales Institute of Engineers, Park Place, Cardiff, "Air Suspension," V. E. Gough, 7.15 p.m.

INSTITUTE OF SHEET METAL ENGINEERING

Wed., March 9.—MIDLAND BRANCH: Byng Kenrick Suite, College of Technology, Gosta Green, Birmingham, Annual General Meeting and Film Show, 6.45 p.m.

INSTITUTE OF WELDING

Wed., March 9.—SOUTH LONDON BRANCH: 54, Princes Gate, London, S.W.7, "The Future of Gas Shielded Welding," A. A. Smith, 7.30 p.m.

INSTITUTION OF AGRICULTURAL ENGINEERS

Mon., March 7.—EAST MIDLANDS, YORKSHIRE AND WEST MIDLANDS CENTRES: Day Visit to Massey-Ferguson, Ltd., Manchester, followed by a paper, "Ground Adhesion Problems of Wheeled Agricultural Tractors," A. Senkowski, 10.45 a.m.
Tues., March 8.—LONDON CENTRE: 6, Queen Square, London, W.C.1, "Equipment for Milking and Milk Handling," H. S. Hall, 2.15 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Wed., March 9.—NORTH WESTERN BRANCH: Lecture Theatre A, The Houldsworth School of Applied Science, The University, Leeds, 2, Joint meeting with the North Western Centre of the Graduates' and Students' Section, "Recent Developments in Heat Transfer," O. A. Saunders, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., March 8.—Great George Street, Westminster, London, S.W.1, Informal discussion on "Deep Excavations," introduced by V. H. Collingridge, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, March 4.—MEDICAL ELECTRONICS DISCUSSION GROUP: Savoy Place, London, W.C.2, Discussion on "Direct Writing Oscillographs," opened by A. Smale and S. N. Pocock, 6 p.m. ★ NORTH-EASTERN CENTRE: Technical College, Carlisle, "The Design and Performance of the Gas-Filled Cable System," E. P. G. Thornton and D. H. Booth, 7 p.m.
Sat., March 5.—LONDON GRADUATE AND STUDENT SECTION: Visit to Big Ben Clock Tower (Clock Mechanism and Broadcast Arrangements), 10.30 a.m.
Mon., March 7.—ELECTRONICS AND COMMUNICATIONS SECTION: Savoy Place, London, W.C.2, "An Introduction to the Theory of Masers with particular reference to the Travelling-Wave Maser," P. N. Butcher, 5.30 p.m. ★ NORTH-EASTERN CENTRE: Neville Hall, Westgate Road, Newcastle upon Tyne, Second Hunter Memorial Lecture, "The Protection of Electrical Systems," H. G. Bell, 6.15 p.m. ★ SOUTH MIDLAND CENTRE: James Watt Memorial Institute, Birmingham, combined meeting with the Graduate and Student Section: "Reliability of Electrical Components in Automatic Machines," P. D. Guest; and "Preventing Crane Collisions Electronically," R. J. Meredith, 6.30 p.m. ★ SOUTH MIDLAND ELECTRONICS AND MEASUREMENT GROUP: Winter Gardens, Malvern, Joint meeting with the Malvern and District Group, "Masers," M. H. Oliver, 7.30 p.m.
Tues., March 8.—NORTH-EASTERN CENTRE: College of Further Education, Workington, "The Reliability and Life of Impregnated-Paper Capacitors," J. P. Pitts, 7 p.m. ★ NORTHERN IRELAND CENTRE: David Keir Building, Queen's University, Stranmillis Road, Belfast, "The Recognition of Moving Vehicles by Electronic Means," T. S. Pick and A. Readman, 6.30 p.m. ★ SOUTH-EAST SCOTLAND SUB-CENTRE: Carlton Hotel, North Bridge, Edinburgh, "Water-Turbine-Driven Induction Generators," C. L. C. Allan, 7 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE: Town Hall, Hanley, Faraday Lecture, "Electrical Machines," M. G. Say, 7.30 p.m.
Wed., March 9.—SUPPLY SECTION: Savoy Place, London, W.C.2, "The Impulse Strength of Impregnated-Paper Dielectrics as Used in High-Voltage Cables," B. Salvage and J. A. M. Gibbons, 5.30 p.m. ★ NORTH LANCASHIRE SUB-CENTRE: N.W.E.B. Demonstration Theatre, Friargate, Preston, "The Deltic Locomotive," C. M. Cock, 7.15 p.m. ★ RUGBY SUB-CENTRE: College of Technology and Arts, Rugby, "The Application of Irradiation in Industry," M. C. Crowley-Milling, 6.30 p.m. ★ SOUTHERN CENTRE: S.E.B. Showrooms, Salisbury, "The Transmission of News Film Over the Transatlantic Cable," C. B. B. Wood and I. J. Shelley, 6.30 p.m. ★ OXFORD DISTRICT BRANCH: S.E.B. Service Centre, 37, George Street, Oxford, "Automation of the National Telephone System," H. E. Francis, 7 p.m.
Thurs., March 10.—UTILISATION SECTION: Savoy Place, London, W.C.2, "Some Considerations in the Application of Power Rectifiers and Convertors," J. P. McBreen, 5.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: Philharmonic Hall, Liverpool, Faraday Lecture, "Electrical Machines," M. G. Say, 6.45 p.m. ★ NORTH LANCASHIRE SUB-CENTRE: N.W.E.B. Demonstration Theatre, Duke Street, Barrow, "The Deltic Locomotive," C. M. Cock, 7.15 p.m. ★ NORTH SCOTLAND SUB-CENTRE: Electrical Engineering Department, Queen's College, Dundee, "Silicone Electrical Insulation," J. H. Davis, 7 p.m. ★ WEST WALES (SWANSEA) SUB-CENTRE: Conference Room, S.W.E.B. Showrooms, The Kingsway, Swansea, "Subscriber Trunk Dialling," D. A. Barron, 6 p.m. ★ IRISH BRANCH: Physical Laboratory, Trinity College, Dublin, "Aviation Communications and Navigational Systems," G. E. Enright and G. Jones, 6 p.m.
Fri., March 11.—NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, "Silicone Electrical Insulation," J. H. Davis, 7.30 p.m.
Sat., March 12.—LONDON GRADUATE AND STUDENT SECTION: Visit to Big Ben Clock Tower, 10.30 a.m.

INSTITUTION OF ENGINEERS-IN-CHARGE

Wed., March 9.—Kent Room, Caxton Hall, Westminster, London, S.W.1, "Atmospheric Pollution, Its Measurement and Alleviation," R. Jackson, 6.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., March 8.—39, Elmbank Crescent, Glasgow, "Some Uses of Computers in Shipbuilding and Engineering," N. L. Lawrie, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

To-day, March 4.—LONDON BRANCH: Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "New Methods of Automatic Traffic Control," E. Bailey and E. Thorpe, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, March 4.—SCOTTISH BRANCH: Robert Gordon's College, Aberdeen, "Noise and Hearing: Physiological Aspects," W. Burns, and "Origins of Diesel-Engine Noise," A. E. Austen and T. Priede, 7.30 p.m.
Mon., March 7.—SOUTHERN BRANCH: Royal Pavilion Hotel, Brighton, Informal Meeting, Discussion opened by S. H. Harding, 7.15 p.m.
Tues., March 8.—AUTOMOBILE DIVISION ORDINARY MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, "Some Problems in the Design of Crawler Tractors," L. F. Little, 6 p.m. ★ N.E. BRANCH: Cleveland Institute, Corporation Road, Middlesbrough, "Design and Development of Machine Tools," C. A. Sparkes, 6.15 p.m.
Wed., March 9.—ORDINARY MEETING IN CONJUNCTION WITH THE HYDRAULICS GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, "Power, Flow and Pressure Measurements in Pump Testing," Leslie Young and R. A. Nixon, 6 p.m. ★ EASTERN GRADUATES' SECTION: Visit to C.I.B.A. (A.R.L.), Duxford, 7 p.m. ★ YORKSHIRE GRADUATES' SECTION: Afternoon visit to English Steel Corporation, Ltd., Sheffield,
Thurs., March 10.—SOUTHERN BRANCH: Technical College, Reading, Discussion on "The Harwell Proton-synchrotron," P. Bowles, 7.30 p.m. ★ E. MIDLANDS GRADUATES' SECTION: Technical College, Lincoln, Film Show, 7.15 p.m.
Fri., March 11.—WESTERN BRANCH: Technical College, Gloucester, "Powder Metallurgy Applications," B. H. Swan 7.30 p.m.
Sat., March 12.—SOUTHERN BRANCH: Visit to the works of J. and E. Hall, Ltd., Dartford, 9 a.m. ★ SOUTHERN GRADUATES' SECTION: Visit to the British Internal Combustion Engine Research Establishment, Slough, Bucks, 9.30 a.m.
Tues., March 15.—S. WALES BRANCH: Kingsway Demonstration Theatre, S. Wales Electricity Board, Swansea, "Effect of Nuclear Radiation on Engineering Materials," A. H. Cottrell, 6 p.m. ★ EASTERN GRADUATES' SECTION: Visit to Building Research Station, Watford, 2 p.m.

INSTITUTION OF PLANT ENGINEERS

Tues., March 8.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, Branch Annual General Meeting, 7.15 p.m.
Wed., March 9.—DUNDEE BRANCH: Tay Park Hotel, West Ferry, Branch Annual General Meeting, 7.30 p.m. ★ E. MIDLANDS BRANCH: County Hotel, Theatre Square, Nottingham, Branch Annual General Meeting, 7 p.m. ★ KENT BRANCH: The Kings Head Hotel, High Street, Rochester, Branch Annual General Meeting, 7 p.m. ★ LEICESTER BRANCH: Bell Hotel, Leicester, Branch Annual General Meeting, 7.30 p.m.
Thurs., March 10.—N.E. BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, Annual General Meeting, 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, March 4.—SOUTHERN REGION: Polygon Hotel, Southampton, Annual General Meeting, 8 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., March 8.—MIDLAND COUNTIES BRANCH: Electricity Showrooms, Irongate, Derby, "The Structural Use of Prestressed Concrete in Buildings C.P.115," A. W. Hill, 6.15 p.m.
Wed., March 9.—WALES AND MONMOUTHSHIRE BRANCH: Mackworth Hotel, Swansea, Junior Members' Evening, 6.30 p.m.
Thurs., March 10.—11, Upper Belgrave Street, London, S.W.1, "New Developments in Structural Analysis and Design by Means of the Electronic Computer"; "Application of an Electronic Digital Computer to Structural Steel Design," L. Morgan; "The Analysis of Grid Frameworks and Floor Systems by the Electronic Computer," E. Lightfoot and F. Sawko; "Elastic Critical Loads of Multi-Bay Pitched Roof Portal Frames with Rigid External Stanchions," D. M. Brotton, 6 p.m. ★ LANCASHIRE AND CHESHIRE BRANCH: U.K.A.E.A. (I.G.) Headquarters, Risley, Nr. Warrington, Junior Members' Evening, "The Design and Construction of the Plutonium Criticality Facility Building at Dounreay," G. Evans; "The Construction of a Laminated Timber Hyperbolic Paraboloid Roof," T. L. Holden; "British Railways—London Midland Region Electrification: Reconstruction of Overbridges Between Crewe and Manchester," C. Tucker, 6.30 p.m.
Fri., March 11.—S.W. SECTION: Duke of Cornwall Hotel, Plymouth, "The New Queen Elizabeth Dock at Falmouth," J. D. Norfolk, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, March 4.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Windmills in Colour," Rex Wailes, 7 p.m.
Fri., March 11.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Refrigeration at Sea," D. W. Higham, 7 p.m. ★ N.W. SECTION: Engineers' Club, Albert Square, Manchester, Election of Officers and Film Evening, 7.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY

Thurs., March 10.—Wigan and District Mining and Technical College, "Atomic Energy," G. Brown, 4 p.m.

PLASTICS INSTITUTE

Mon., March 7.—MIDLANDS SECTION: Grand Hotel, Leicester, "Recent Developments in Vacuum Forming Techniques," A. M. Craig, 6.45 p.m.
Wed., March 9.—S. WALES AND MONMOUTHSHIRE SECTION: Angel Hotel, Cardiff, "The Processing and Properties of Polypropylene," J. G. Nichols and C. D. Wells, 6.30 p.m. ★ YORKSHIRE SECTION: St. Mark's House, 186, Woodside Lane, Leeds, 12, "P.V.C. Coated Metals," W. E. Martin, 7.15 p.m.

REGIONAL ADVISORY COUNCIL FOR TECHNOLOGICAL EDUCATION

Tues., March 8.—Fyvie Hall, The Polytechnic, Regent Street, London, W.1, Conference on "The Changing Pattern of Electrical Engineering Education and Training," 10.30 a.m. to 12.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., March 8.—MIDLANDS COUNTIES BRANCH: Midland Institute, Paradise Street, Birmingham, "Theory, Research and the Practical Design of Reinforced Concrete," W. E. J. Budgen, 6 p.m.

ROYAL ASTRONOMICAL SOCIETY AND ROYAL METEOROLOGICAL SOCIETY

To-day, March 4.—Royal Society of Arts, John Adam Street, London, W.C.2, Joint Discussion on "The British Rocket Programme," opened by H. S. W. Massey 2.30 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., March 7.—ORDINARY GENERAL MEETING: 12, Great George Street, Westminster, S.W.1, "Investment in Real Estate," G. W. Bridge, 5.45 p.m.

ROYAL SOCIETY

Thurs., March 10.—Burlington House, Piccadilly, London, W.1, "Bernard Price Institute of Geophysical Research," A. L. Hales, 4.30 p.m.

ROYAL STATISTICAL SOCIETY

Tues., March 8.—EDINBURGH GROUP: Chamber of Commerce, 25, Charlotte Square, Edinburgh, "A Case History in Operational Research," K. D. Tocher, 7.30 p.m. ★ MERSEYSIDE GROUP: Department of Education, The University, Abercromby Square, Liverpool, "Statistical Tests of the Accuracy of Weighing," D. H. Ward, 7 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Mon., March 7.—CORROSION GROUP AND THE YORKSHIRE SECTION: Grand Hotel, Leopold Street, Sheffield, "Corrosion Problems of High Temperature Pressurised Water Reactors," J. N. Wanklyn, 7 p.m.

SOCIETY OF ENGINEERS

Mon. March 7.—Geological Society, Burlington House, Piccadilly, London, W.1, "The Progress of British Watch and Clock Production," R. Lenoir, 5.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Mon., March 7.—DATA PROCESSING SECTION: Manson House, 26, Portland Place, London, W.1, "Data Reduction for Guided Weapon Trials at Aberporth," A. S. Younger, G. C. Morgan, and E. S. Mallett, 7 p.m.

SOCIETY FOR WATER TREATMENT AND EXAMINATION

Fri., March 11.—Library, Royal Society of Health, 90, Buckingham Palace Road, London, S.W.1, Annual General Meeting; Symposium on "Pollution of Surface Water Supplies," 9.30 a.m.

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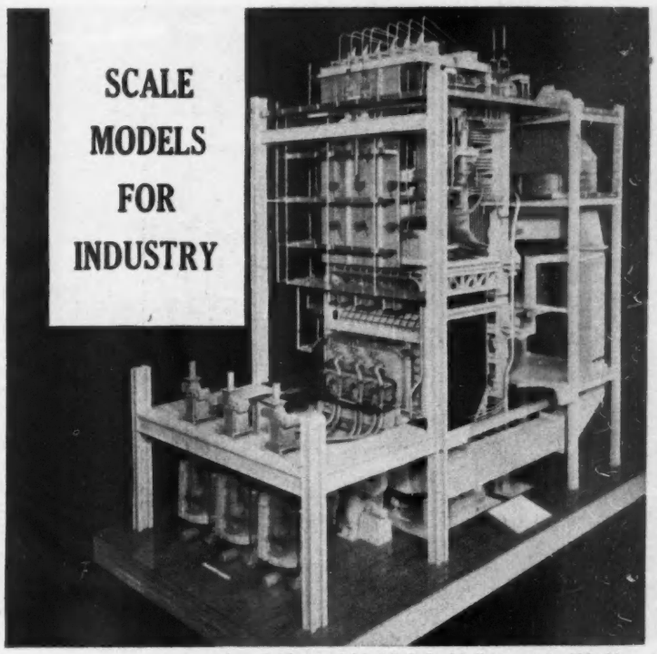

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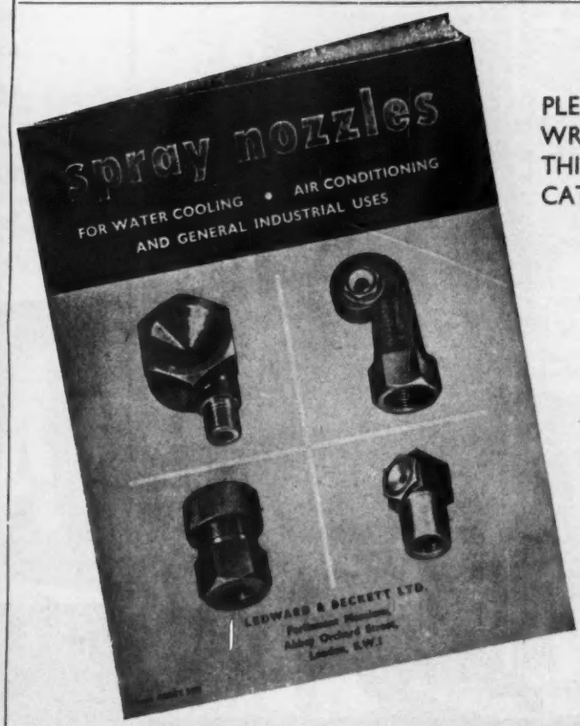

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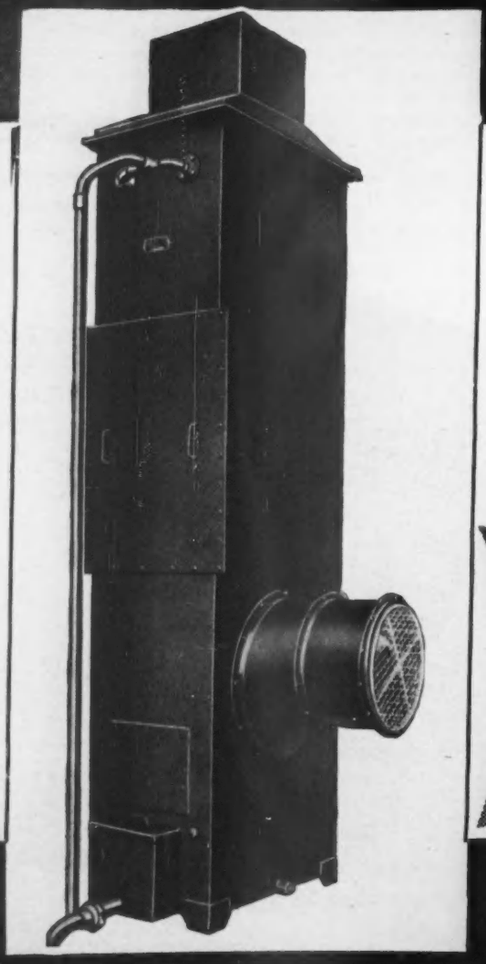

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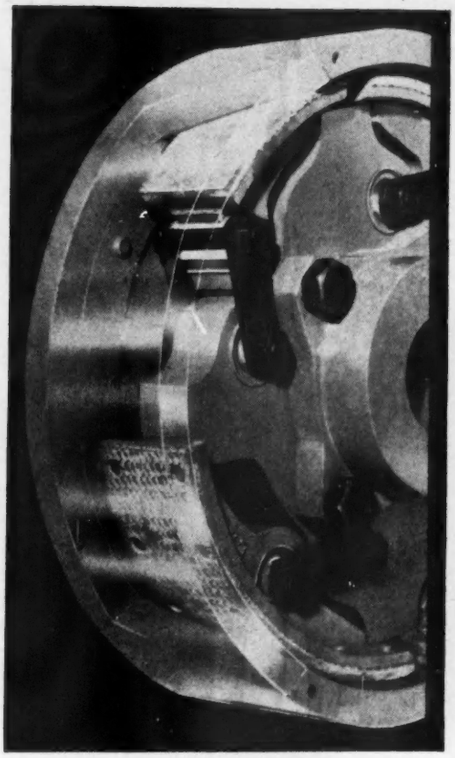

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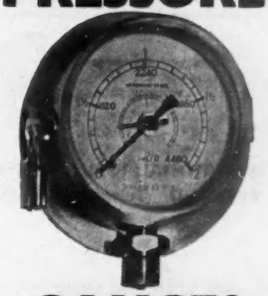

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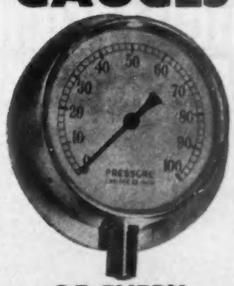

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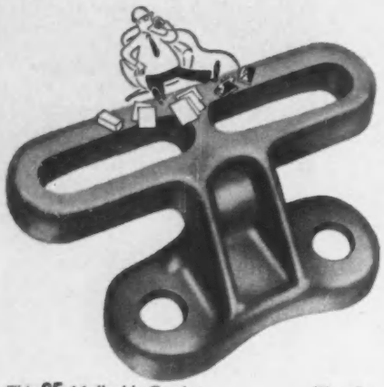

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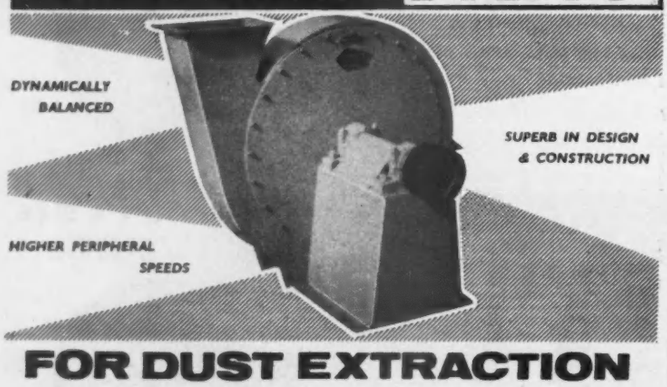

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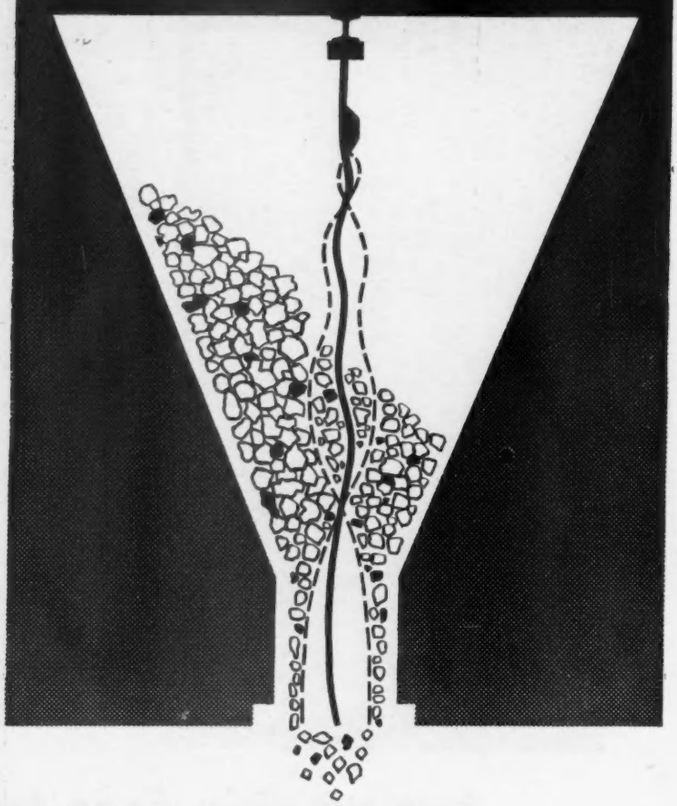

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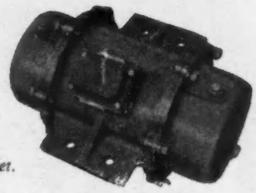

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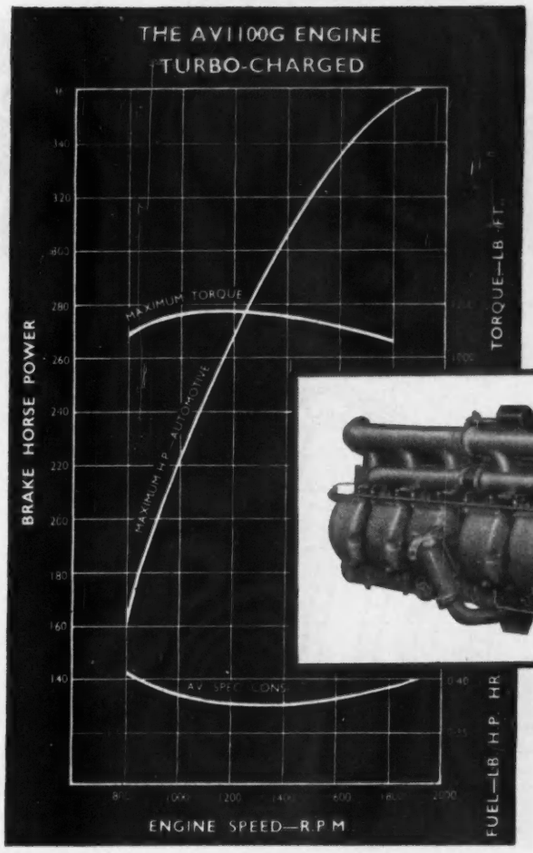

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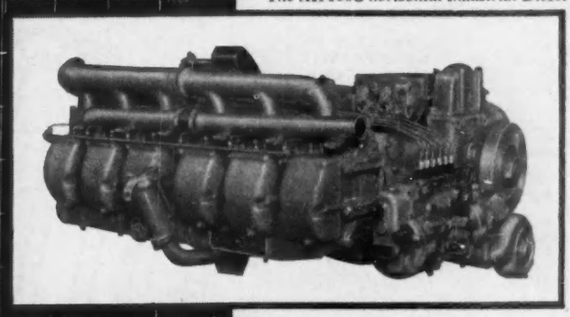

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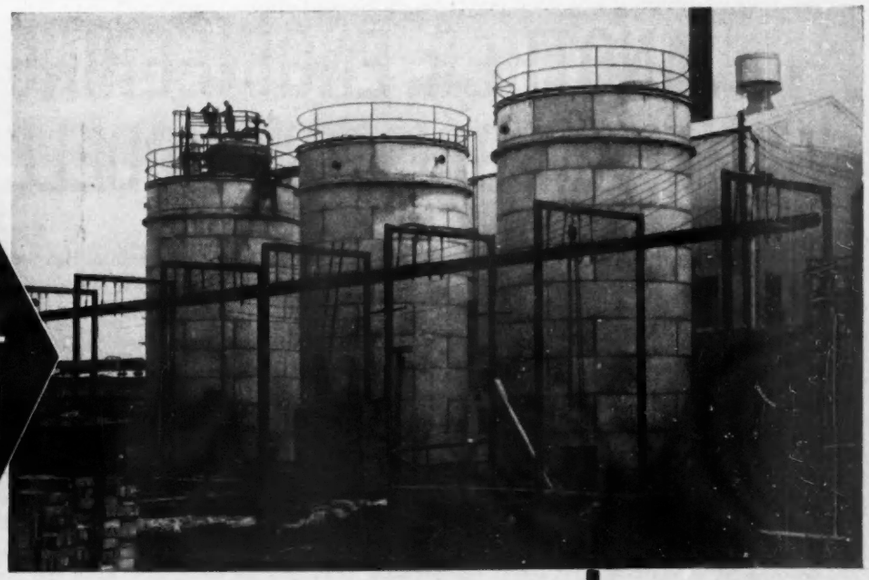

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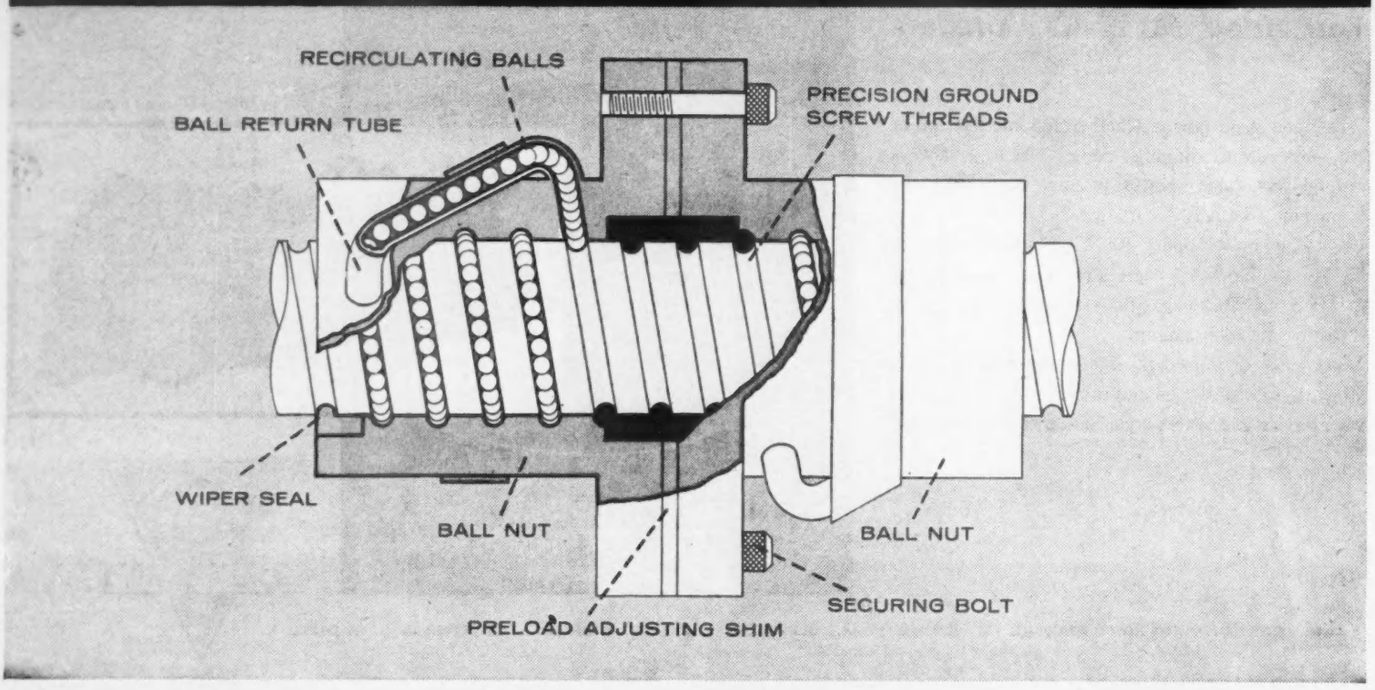

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Bristol Siddeley Beaver ball splines have been developed to eliminate the disadvantages of conventional splines. The designs are very effective in minimising friction, particularly when high torsional and bending loads are imposed during linear movement.

* *Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

For further information please write to:

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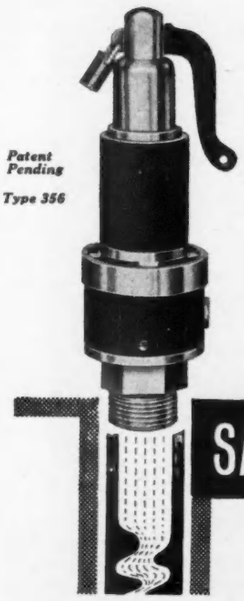

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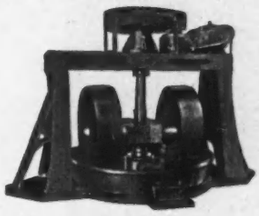

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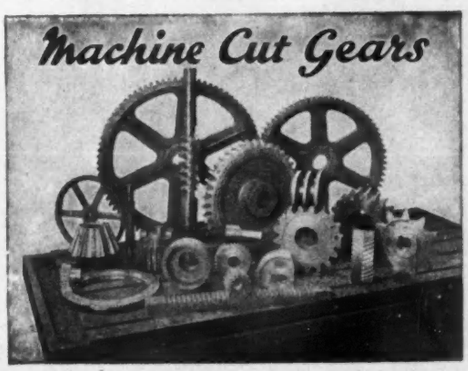

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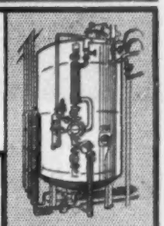

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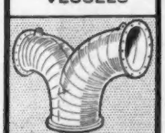
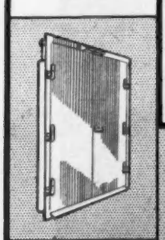


FABRICATED PIPES AND DUCTS



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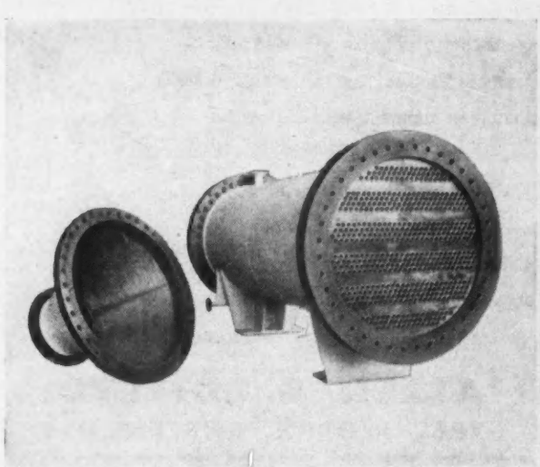
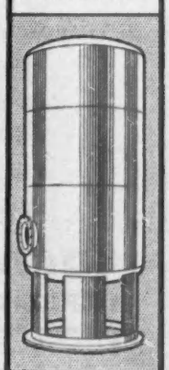


One of a number of specially constructed Heat Exchangers



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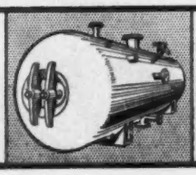
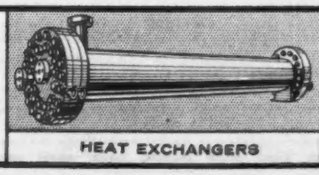


PRESSURE VESSELS



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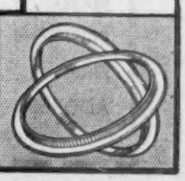

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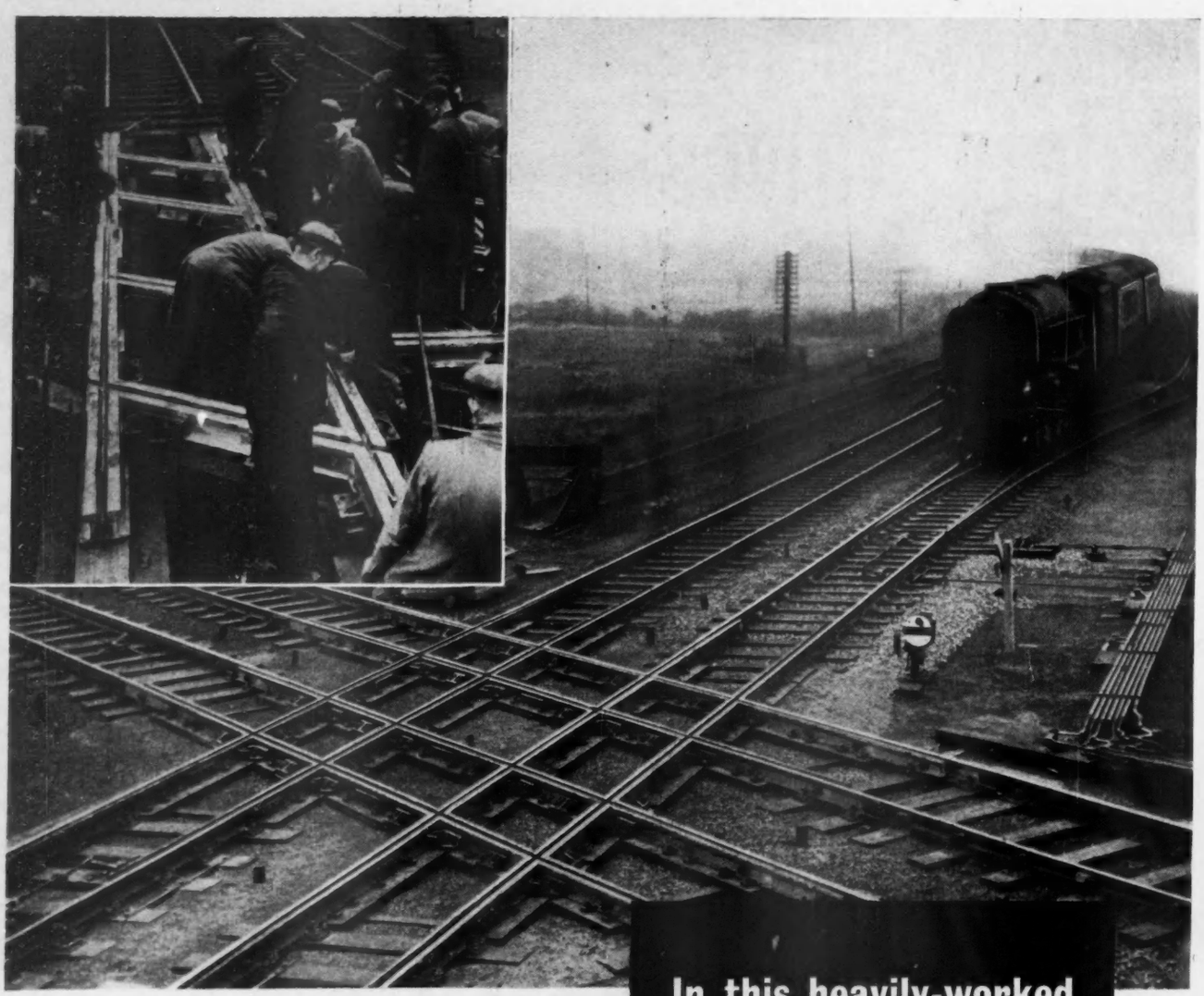

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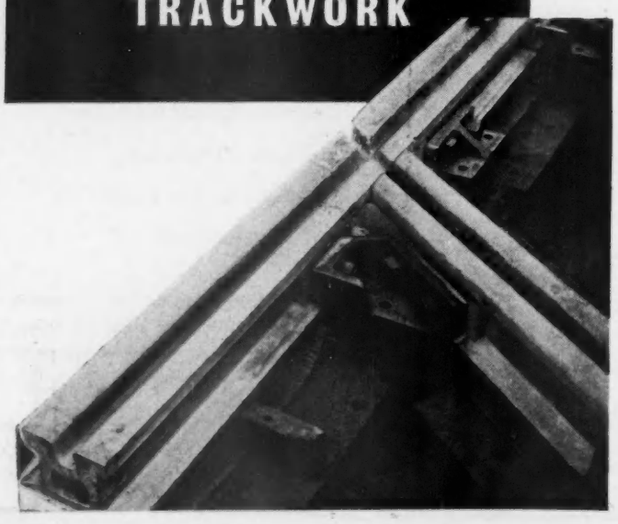

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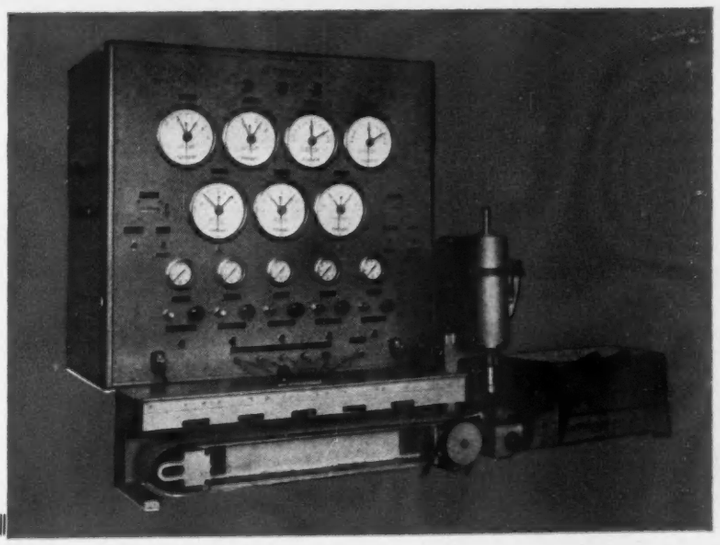

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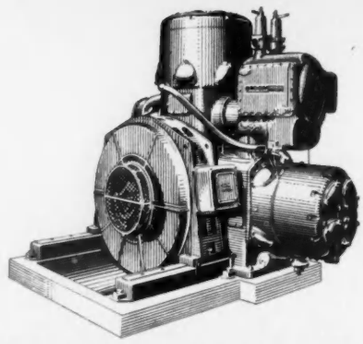

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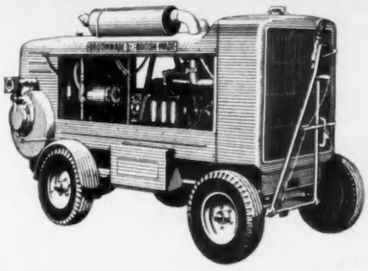

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Incidentally, South Durham have also supplied over 5,000 tons of their "Rendhex" Steel Hexagon Foundation Columns in special lengths for the deep-water foundations to the tanker jetty at Angle Bay.

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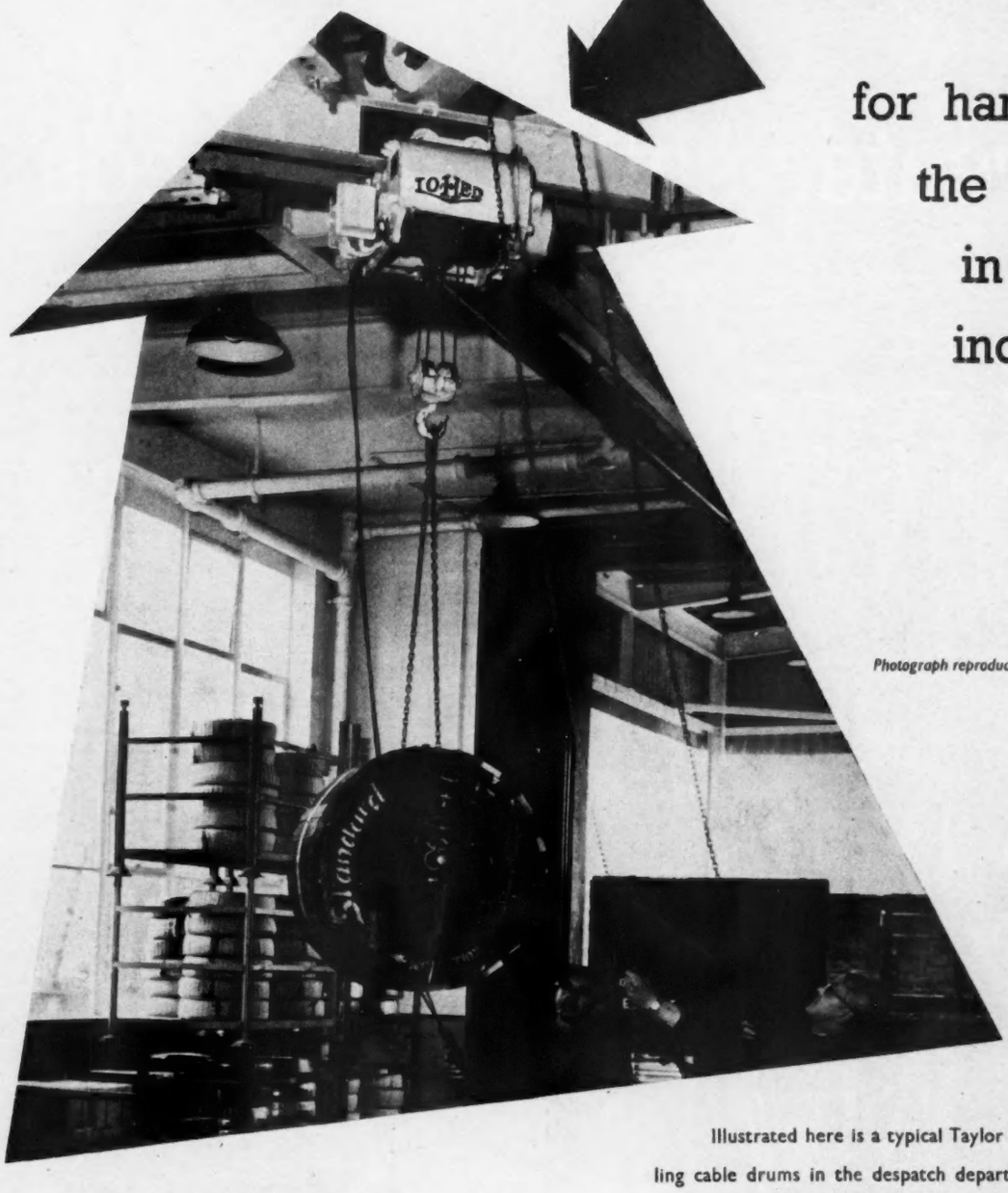

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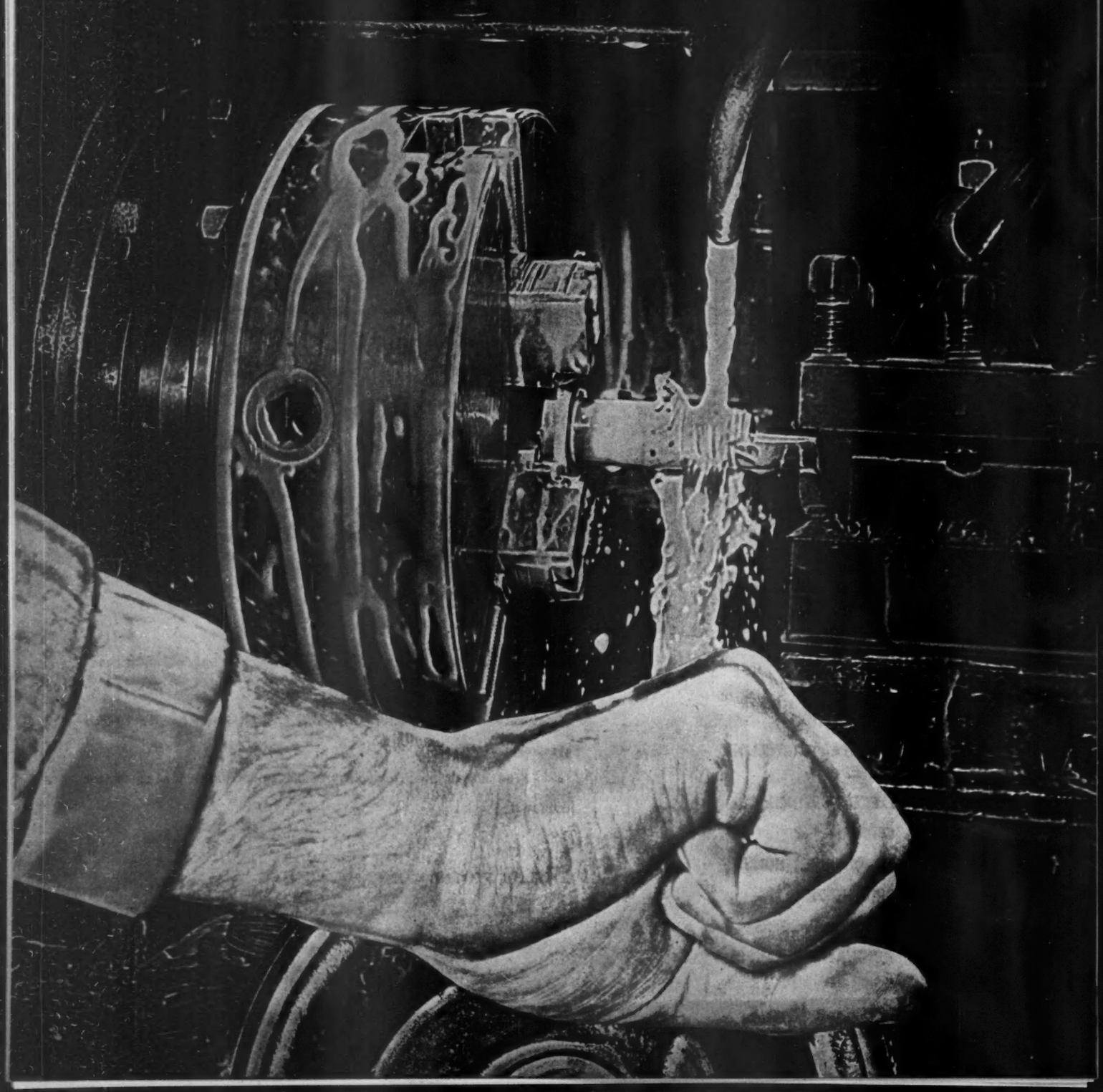


With new Shell Dromus Oils

Most modern soluble cutting oils contain phenolic compounds used as coupling agents between the oil and the emulsifier, for better blending and easier mixing. These phenolic compounds can cause skin irritation, especially where modern high-speed machines are used and the emulsion can concentrate, through the evaporation of water, above the safety level.

Shell research chemists have been working on this problem, which has been causing some concern to Management. After considerable research, Shell Dromus Oils have been reformulated and these new cutting oils now produce bland emulsions, which considerably reduce the risk of skin trouble to operators.

The real difficulty was to find a new coupling agent to replace the phenolic compounds, and Shell finally used what their chemists know as a higher fatty alcohol complex. This solved one problem, but presented another. The new coupling agent was volatile at the high temperatures normally used in blending processes. Further research found a solution to this problem by designing and installing new plant. The new Dromus Oils are every bit as efficient as before and cost no more. They put Management in the welcome position of being able to minimise working hazards at no extra cost. And machine men need no longer be so worried about skin troubles.

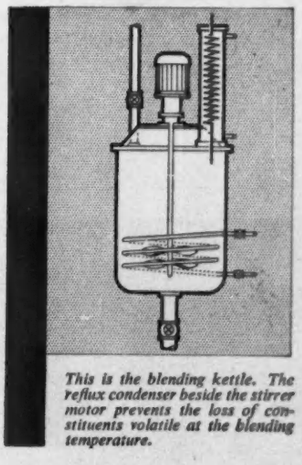
The moral of the story is that Shell research is supremely applicational. The centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right oil for the job. If you and your organisation have any major lubricating problems, it pays to get in touch with your local supplier of Shell Industrial Lubricants.

The Research Story

Shell chemists in the U.K., in Holland and in the U.S.A., prepared and examined hundreds of experimental soluble oils, and established that certain combinations of fatty alcohols could be used in place of phenolic compounds with no loss of efficiency. They set to work to discover the best combination and developed a higher fatty alcohol complex which fitted exactly. Then they realised that to blend this new coupling agent into soluble oils would require special plant and new blending techniques.

Exhaustive testing of blend stability, emulsion stability, anti-corrosion and machining properties led to selection of the most promising blends. A pilot plant was set up to produce batches of these for use in field trials.

This field testing and final development proceeded for two years whilst production plants were erected at points so chosen as to give the most economical and rapid delivery throughout the United Kingdom.



This is the blending kettle. The reflux condenser beside the stirrer motor prevents the loss of constituents volatile at the blending temperature.

NEW SHELL DROMUS SOLUBLE CUTTING OILS

another proof of Shell leadership in lubrication

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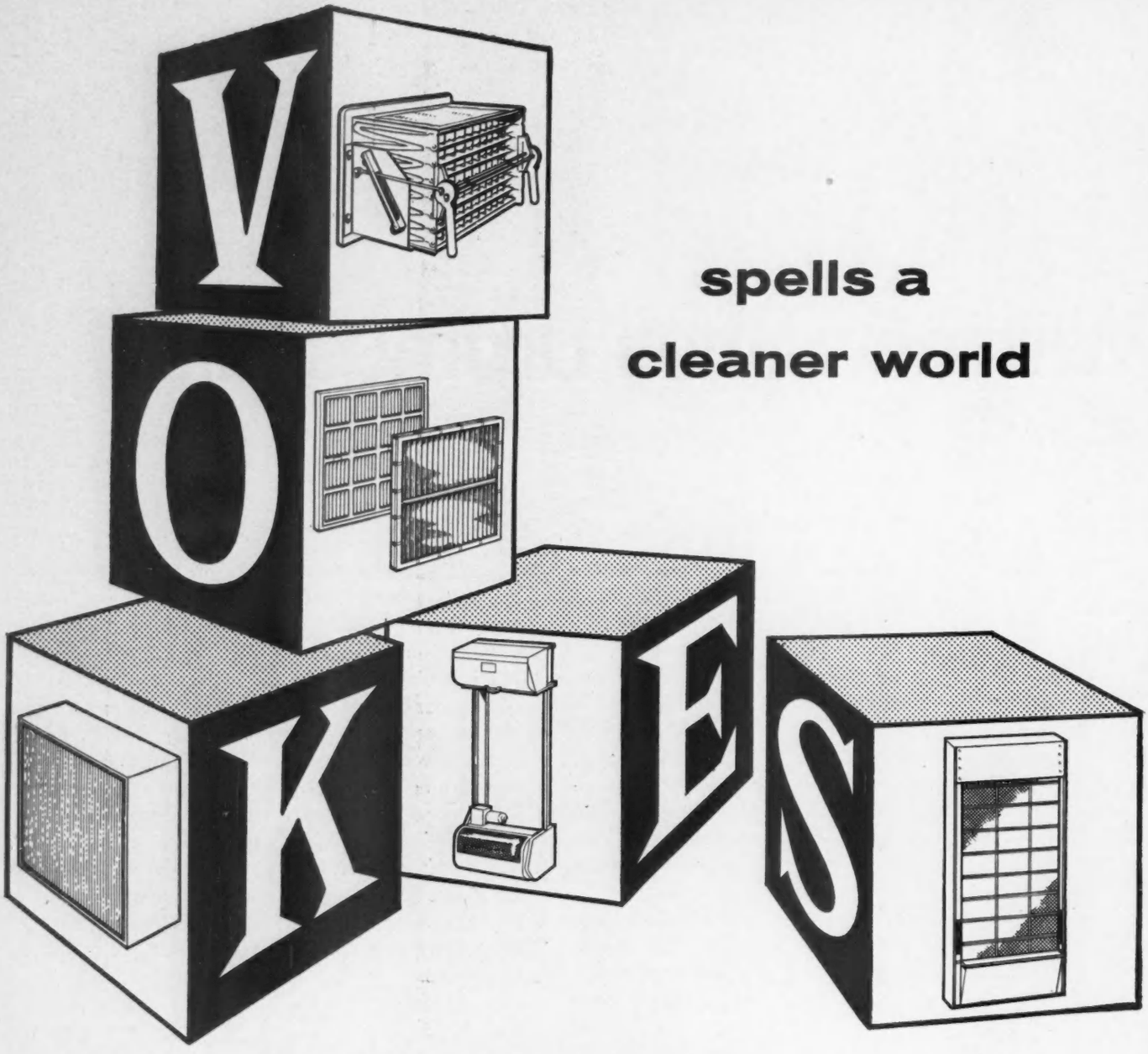

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V **K.600 Kompak.** Normal rating of 600 c.f.m. with an initial resistance of 0.15″w.g. Guaranteed 95% efficient against Aloxite 50 dust. *This is the most widely used air conditioning filter in the country.*

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K **'Absolute'.** Every 'Absolute' filter is tested by the methylene blue dust cloud method and rejected if its efficiency is less than 99.95% against particles in the 0.1 to 0.5 micron range.

E **Autoroll.** Combines large dust holding capacity with low operating and servicing costs. The filter medium (125ft. long) is automatically or manually fed on spools across the air flow.

S **S.C. (Self-Cleaning).** Will clean large quantities of air with minimum maintenance. Special design of filter panels, gives 98% efficiency with an initial resistance of 0.35″w.g. Completely automatic operation. A unique, patented, cleansing device in the oil trough ensures the most efficient degree of continuous self cleaning yet attained.

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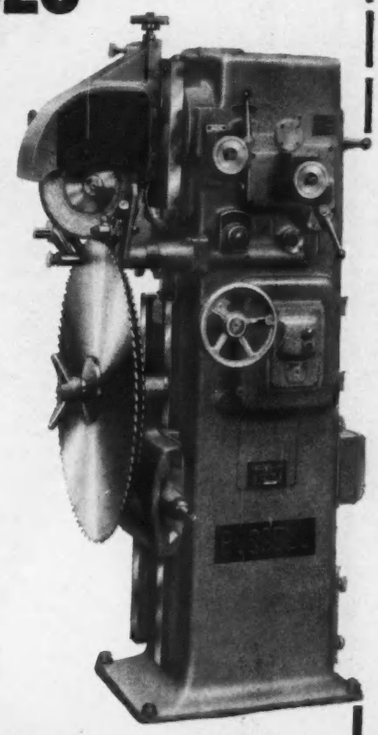

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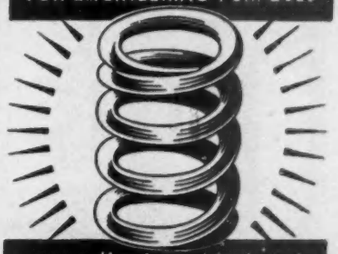

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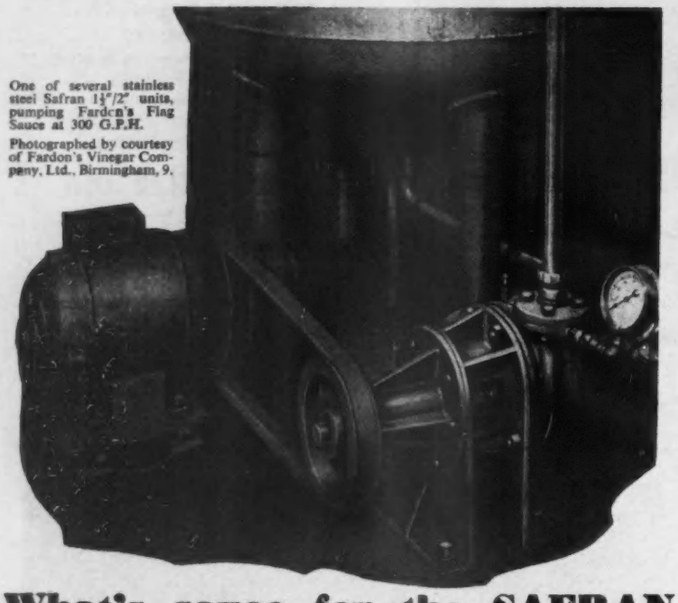

One of several stainless steel Safran 1½"/2" units, pumping Fardon's Flag Sauce at 300 G.P.H.

Photographed by courtesy of Fardon's Vinegar Company, Ltd., Birmingham, 9.

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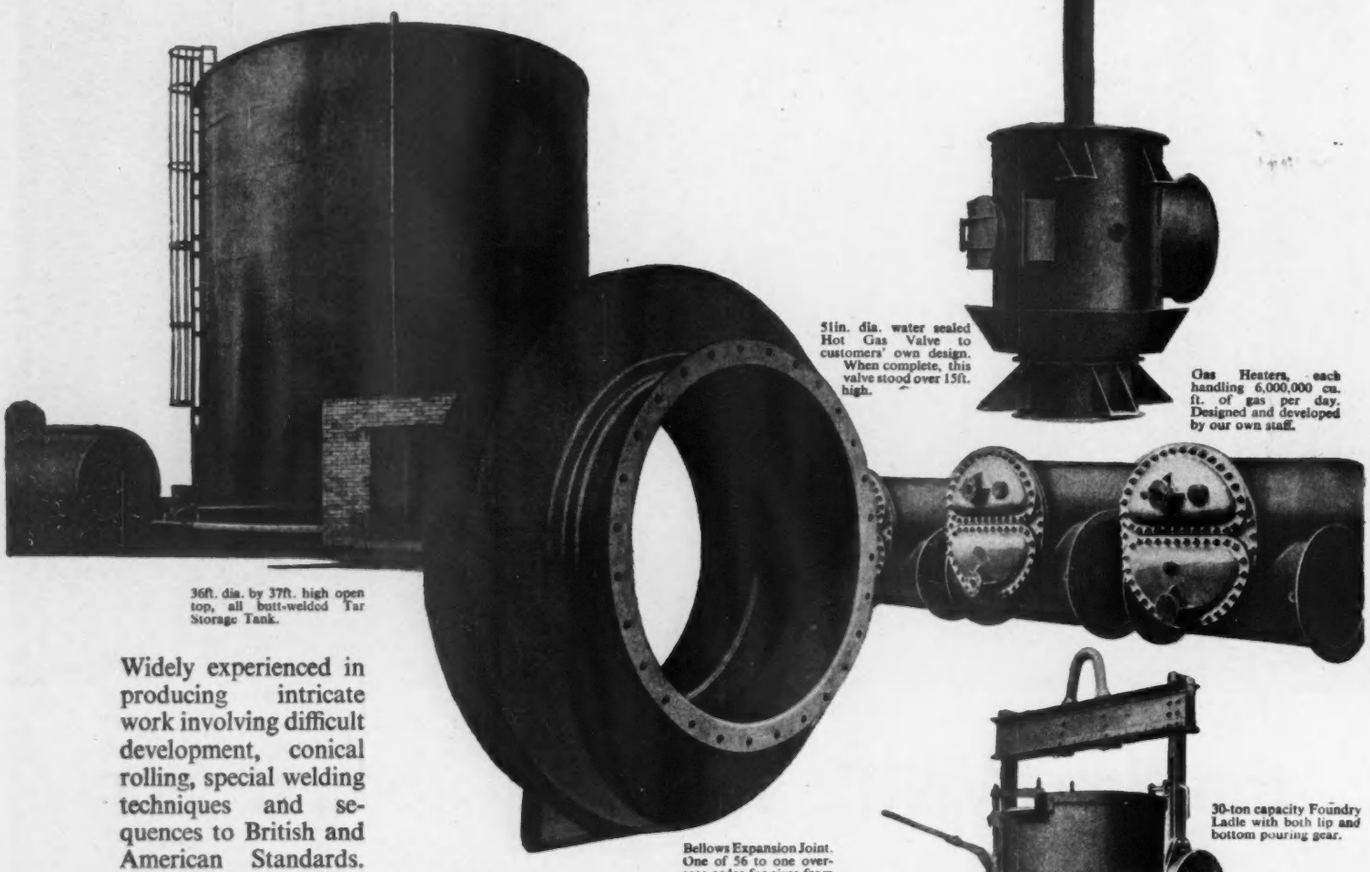

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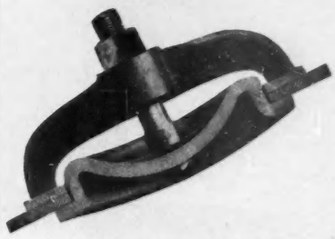

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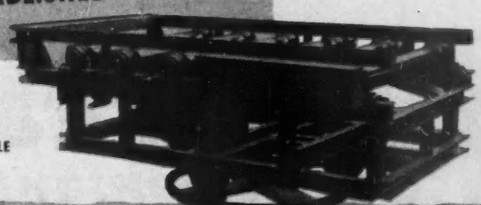

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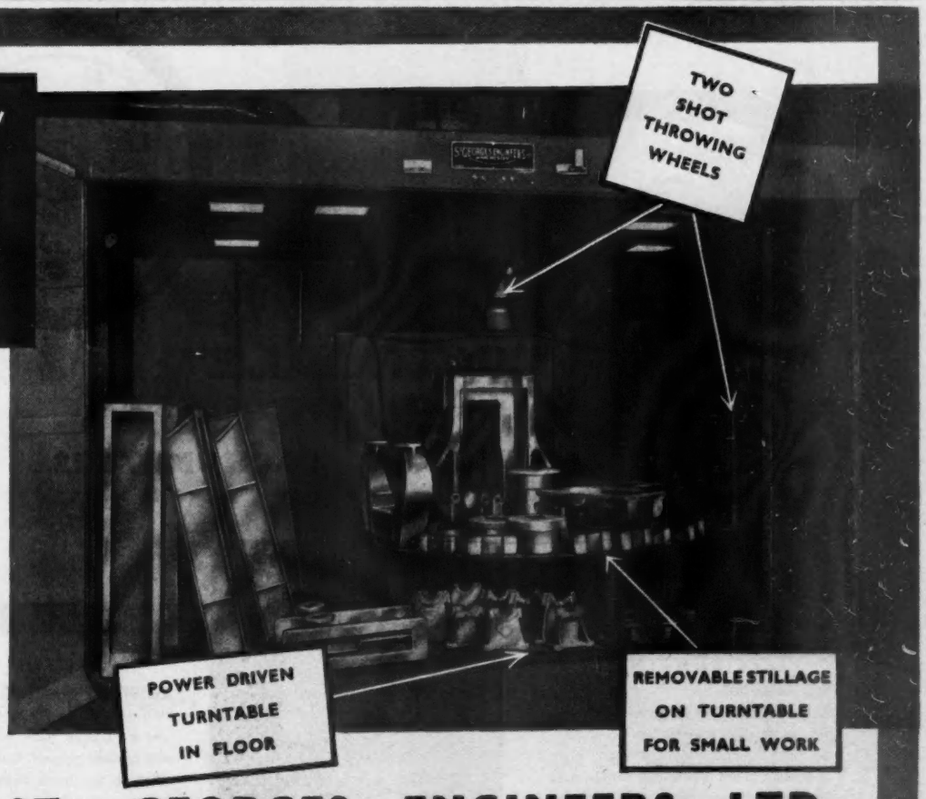

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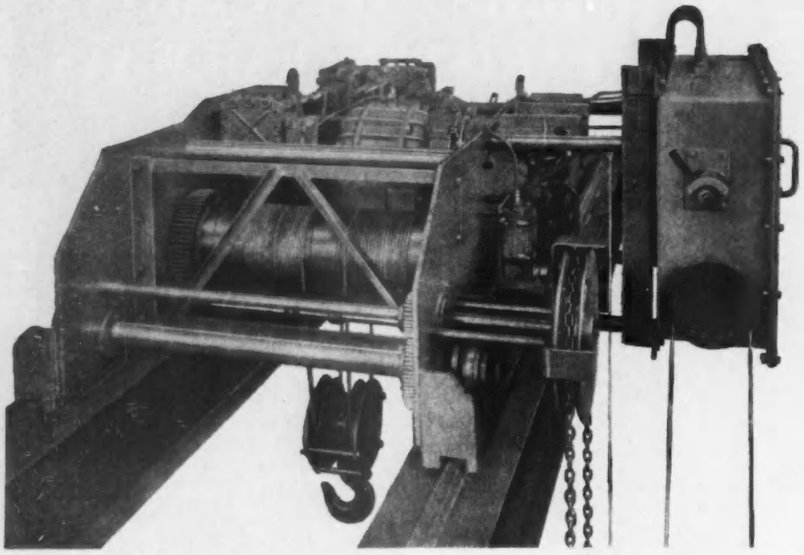

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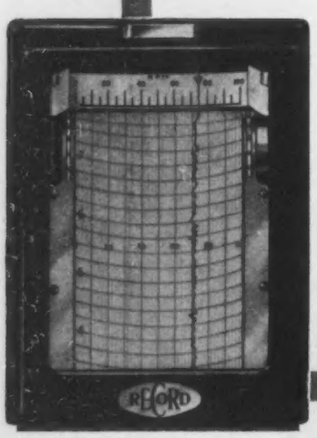

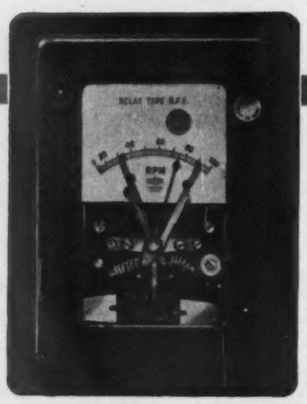

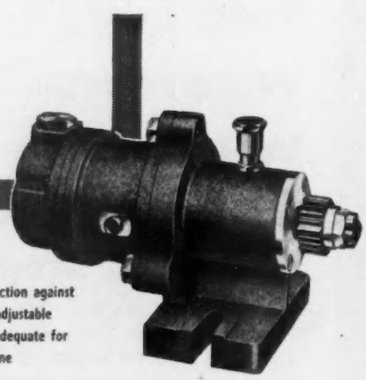

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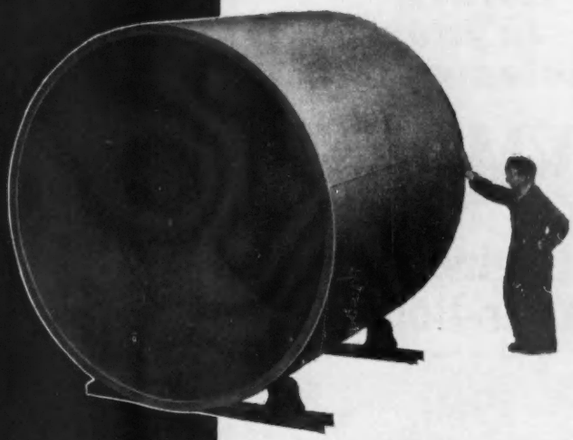

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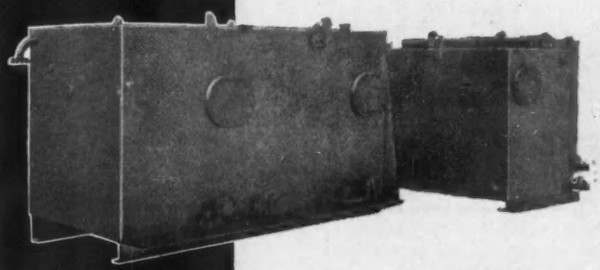

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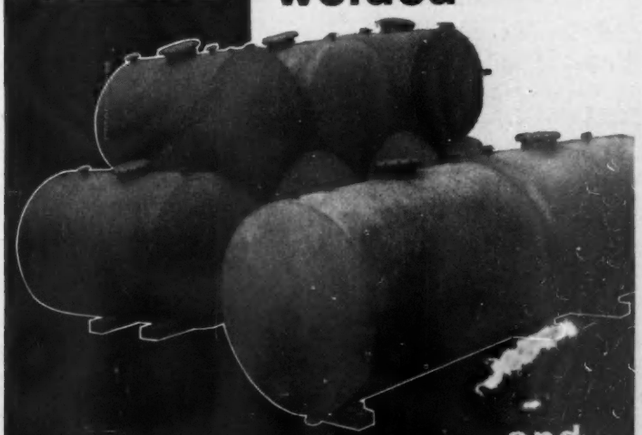

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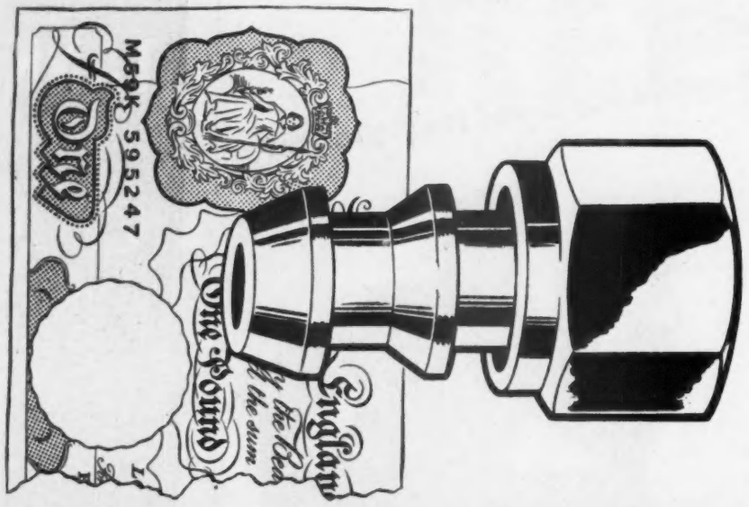

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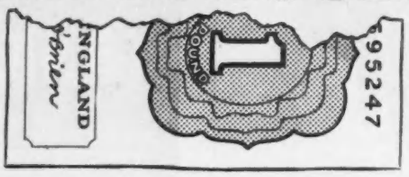

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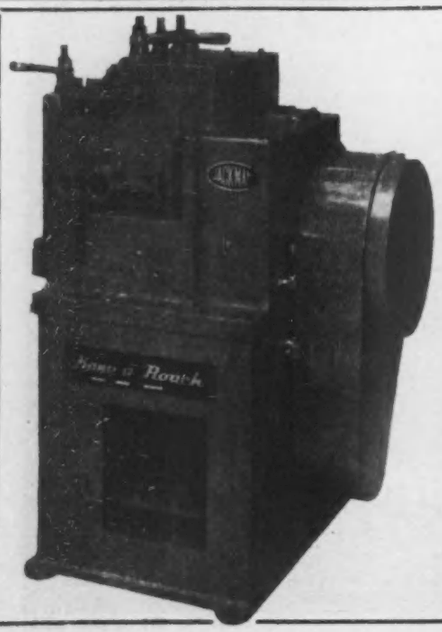

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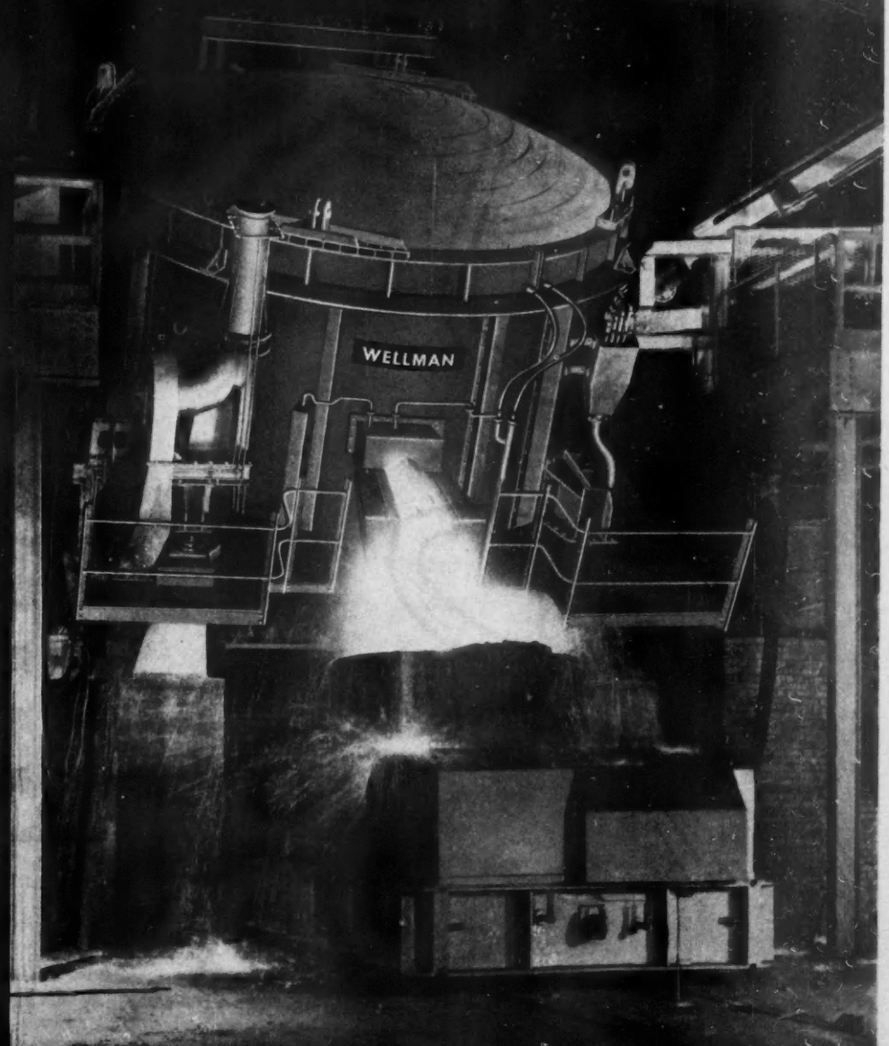

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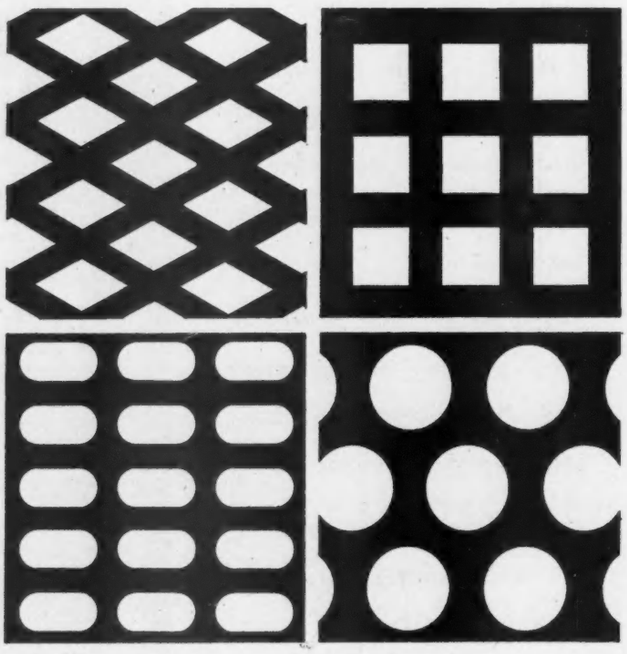

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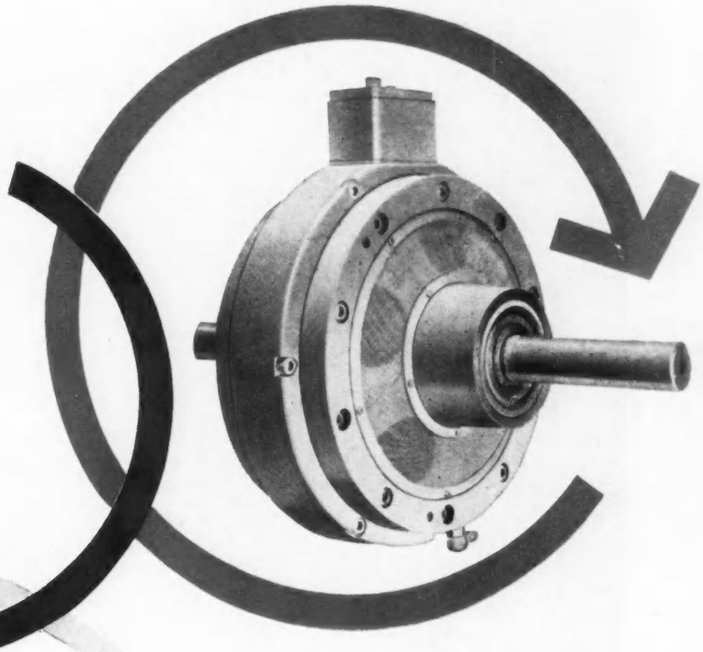

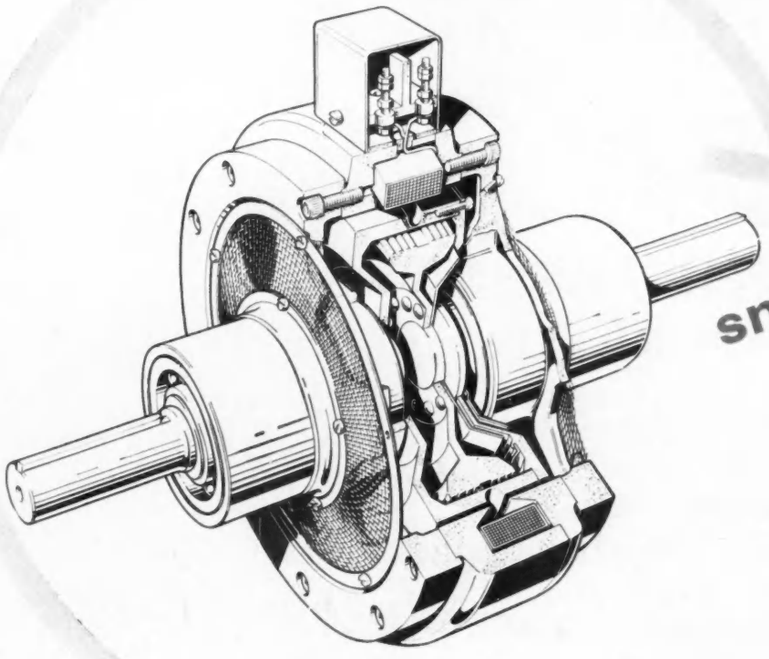

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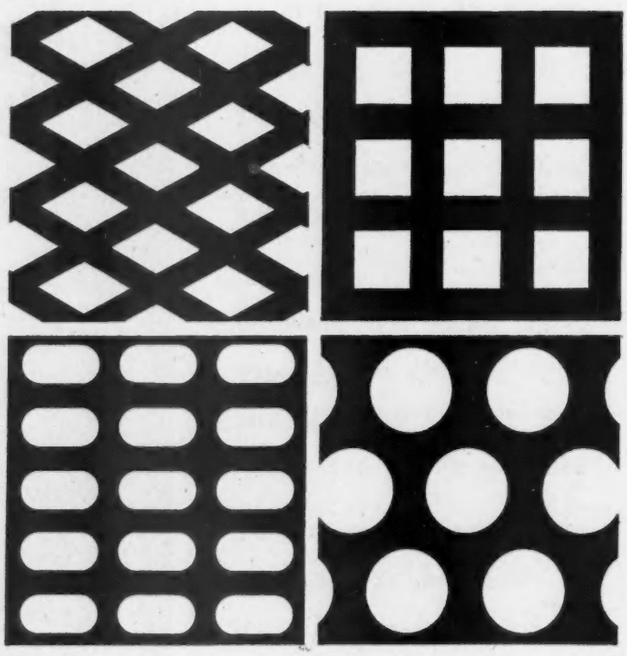

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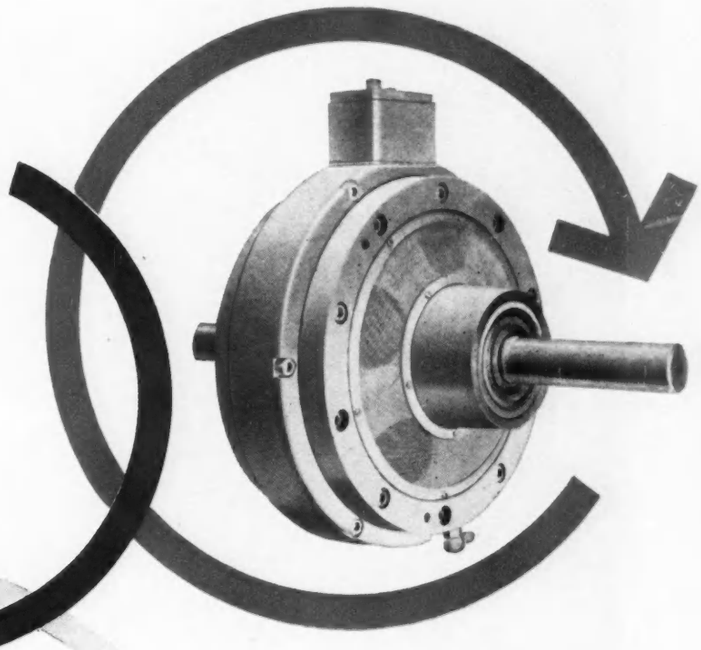

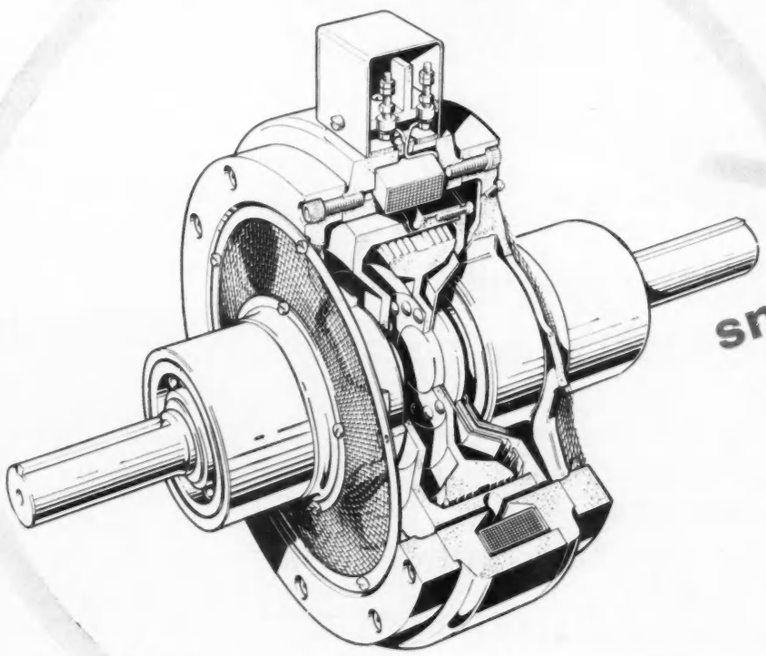

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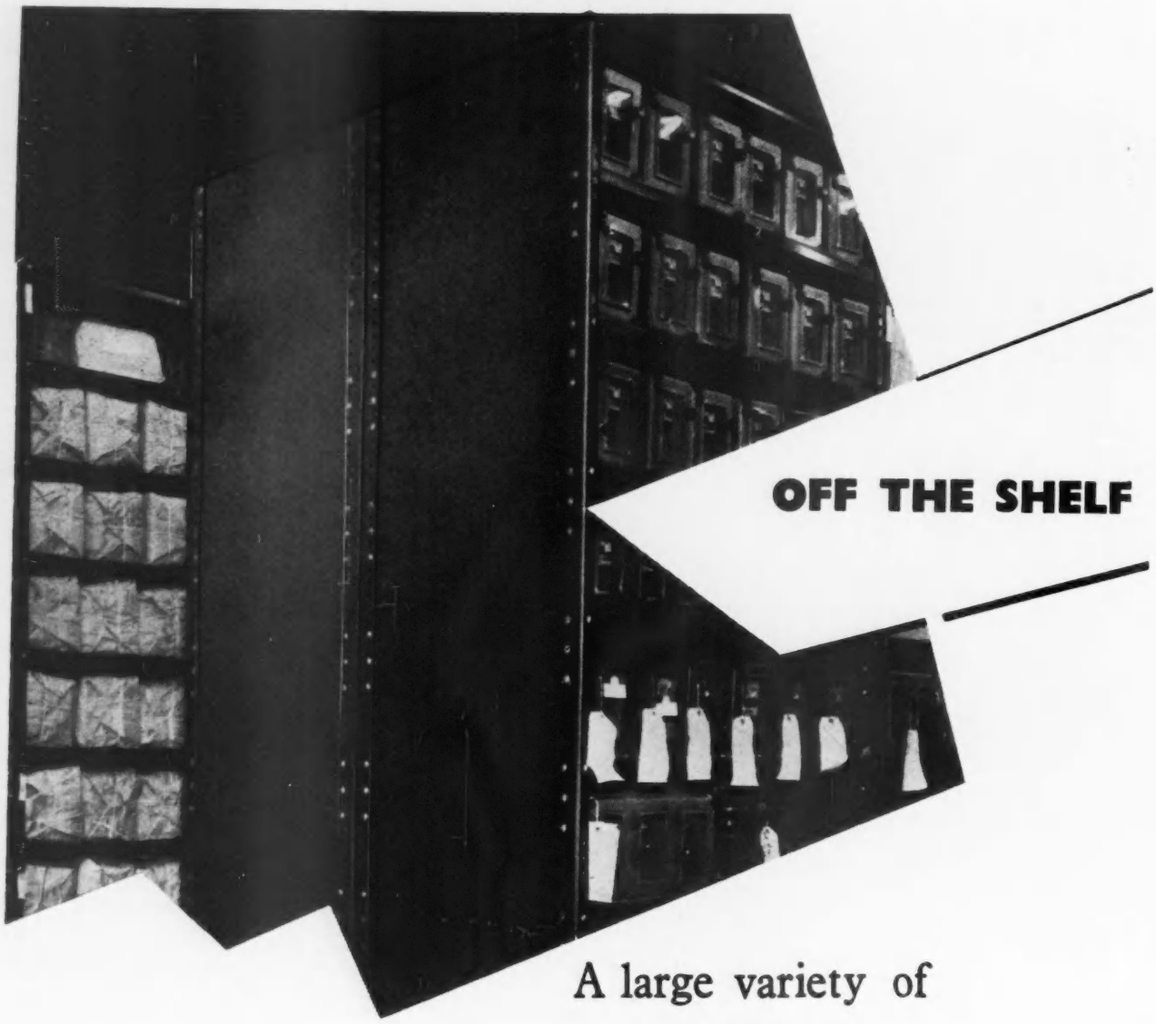

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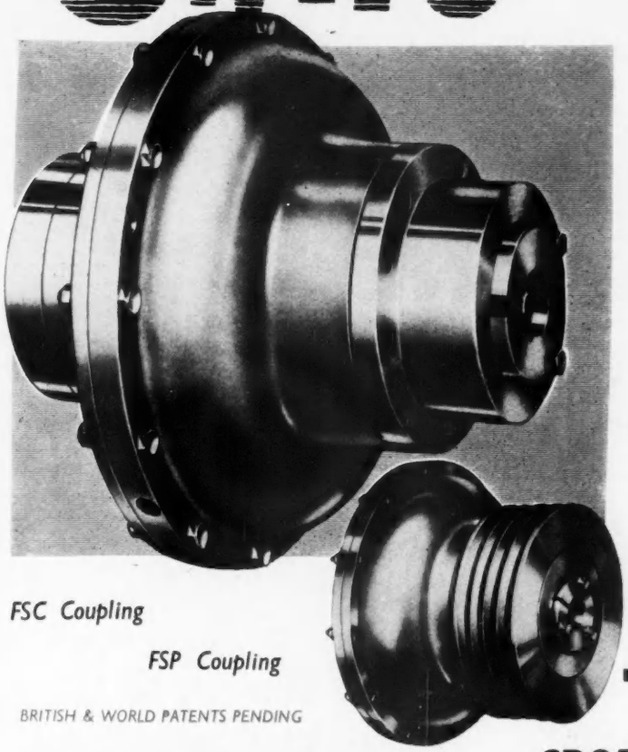

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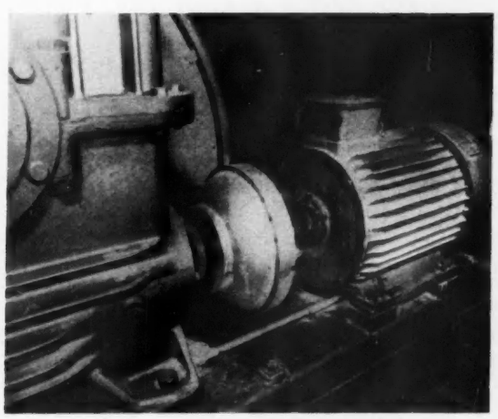

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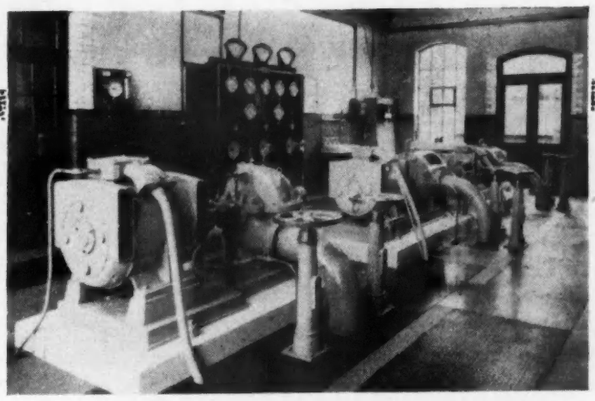

Water Supply Pumping Stations.

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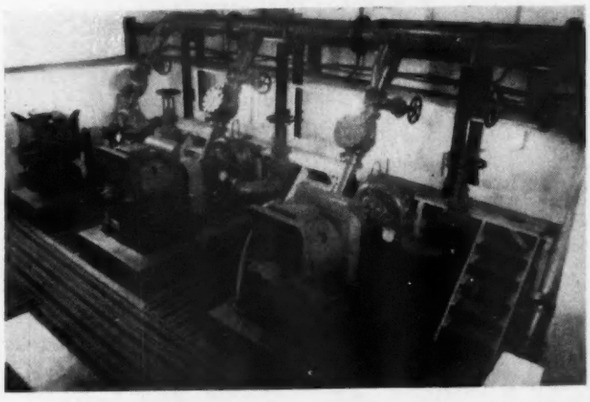

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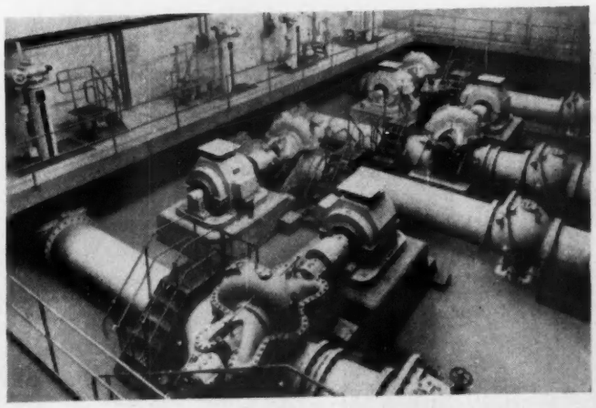
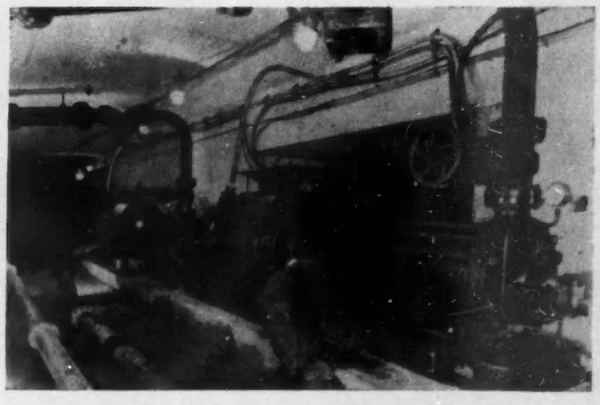


Power Station Water Circulating Pumps.

Mine Drainage Pumps.



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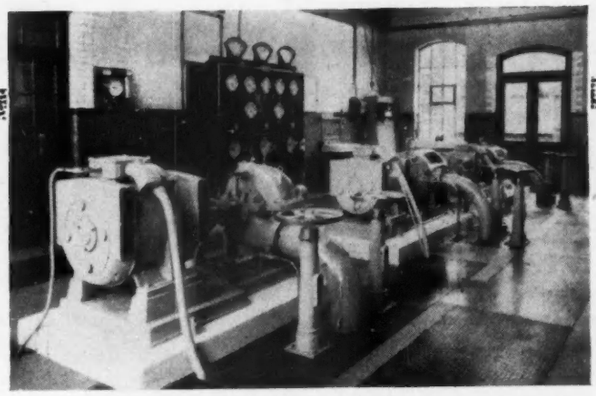
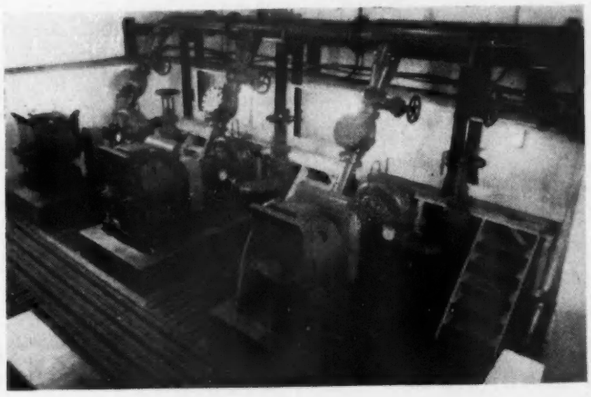


Water Supply Pumping Stations.

MOTORS AND PUMPS



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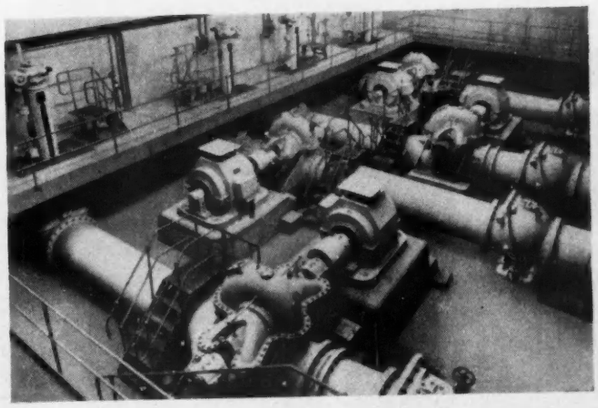

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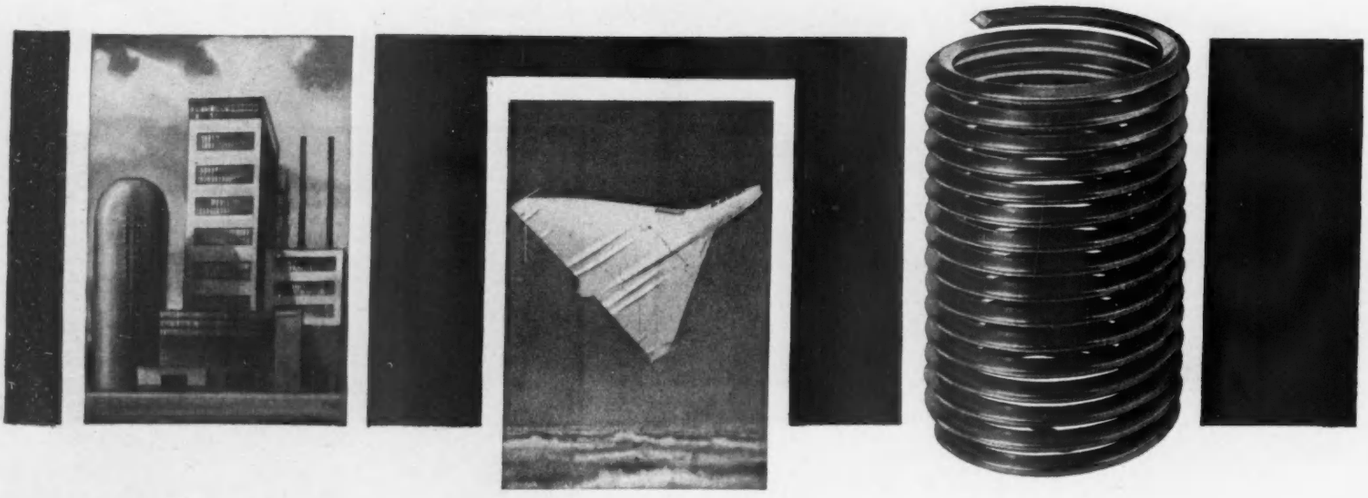

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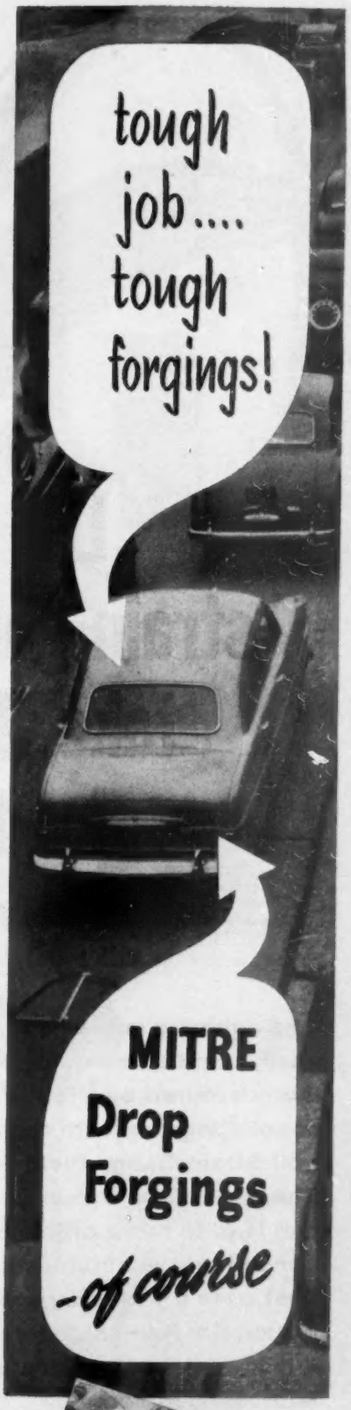

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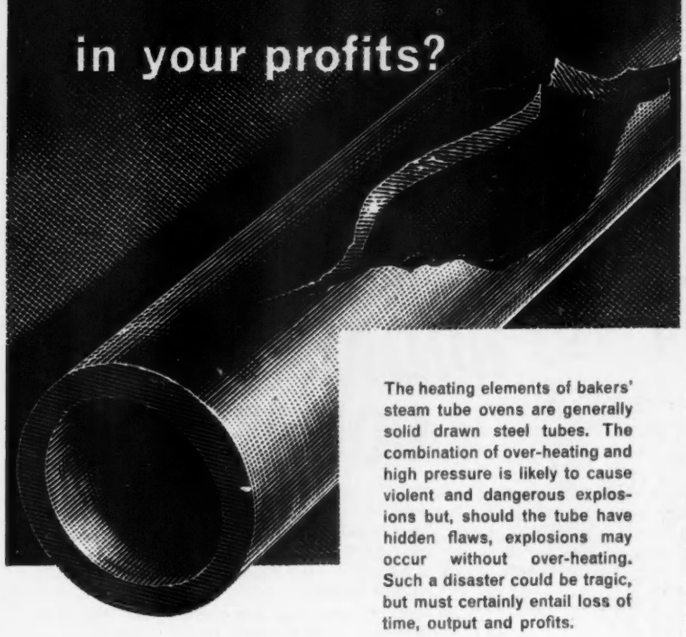

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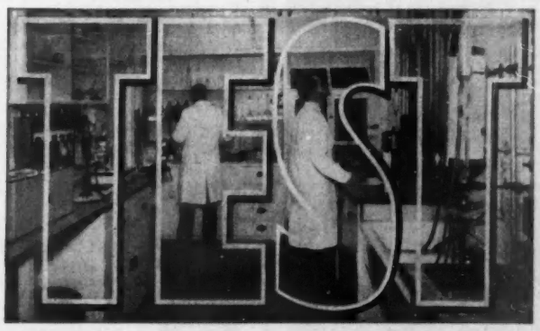

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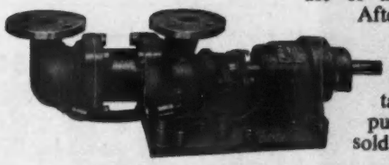

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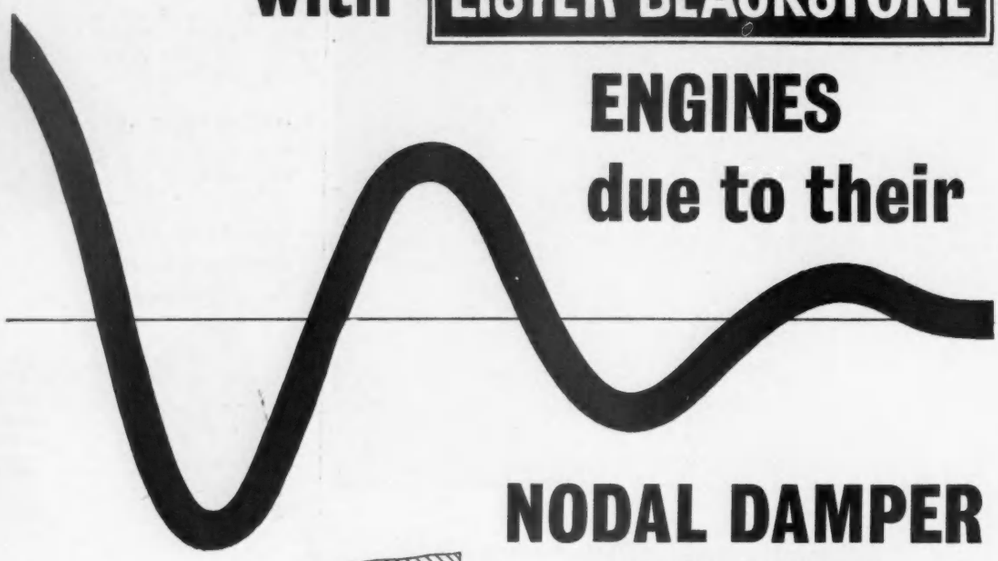

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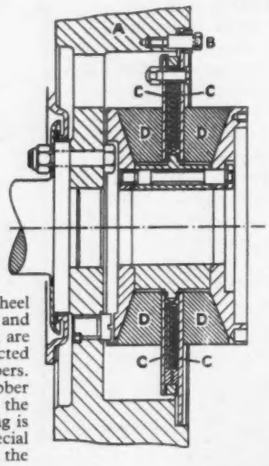

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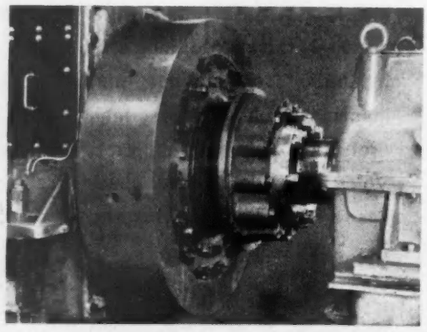

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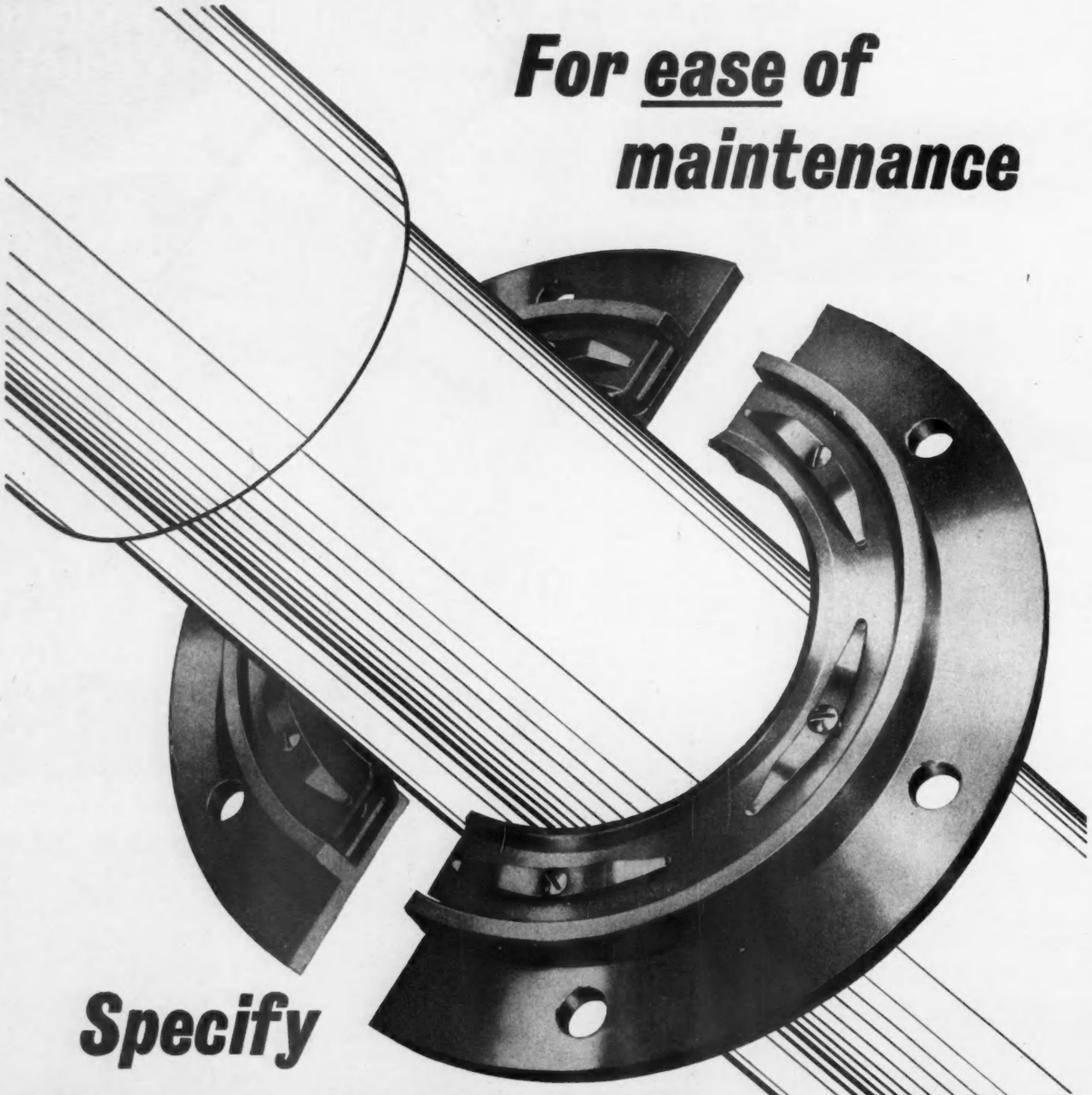

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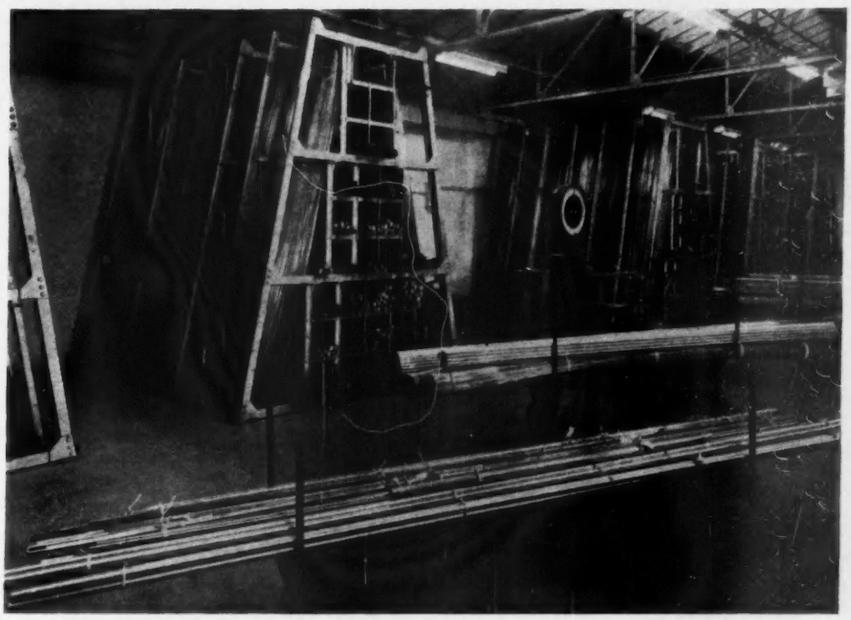

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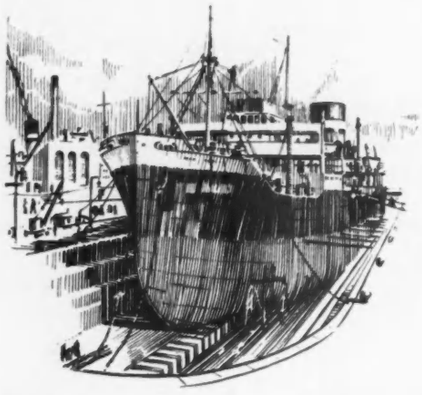

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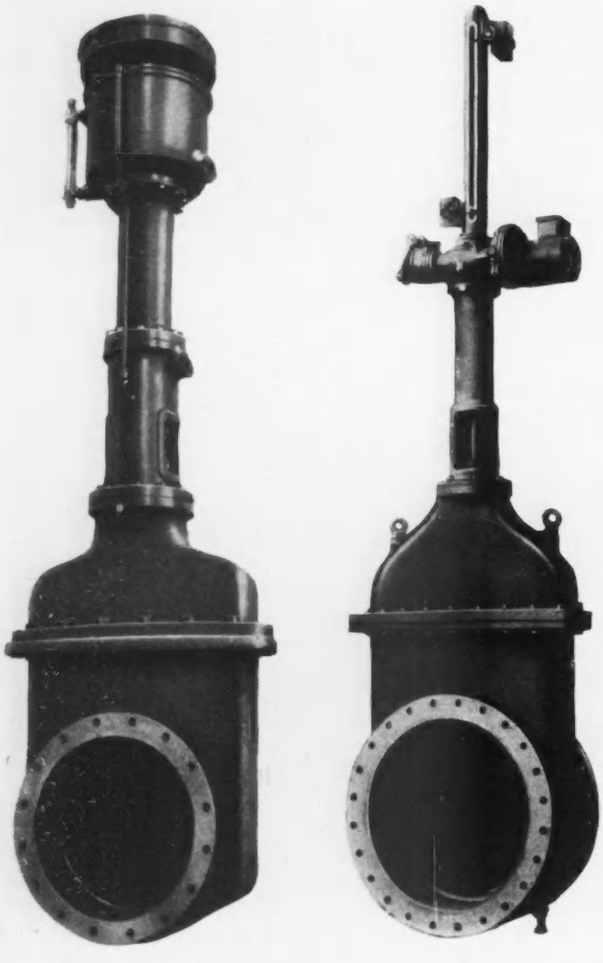

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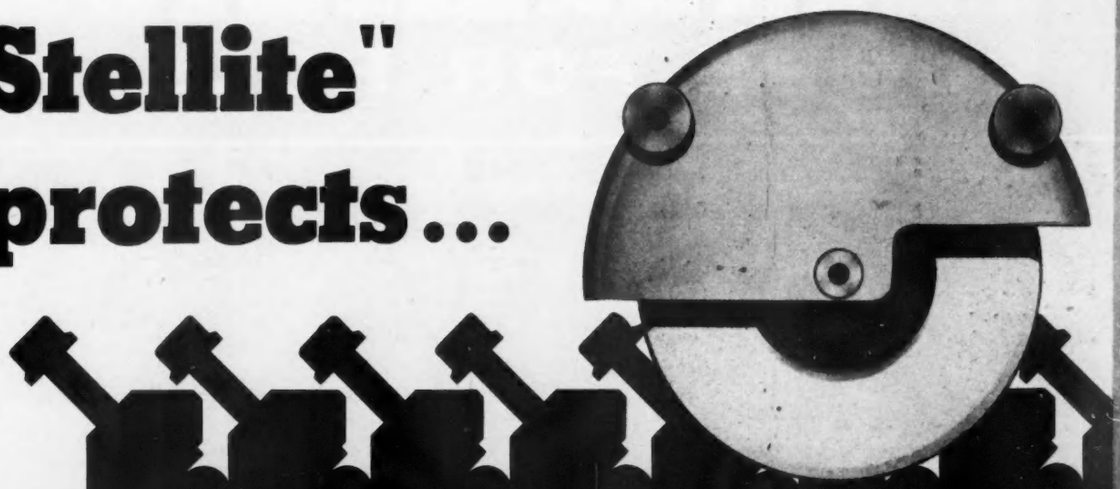

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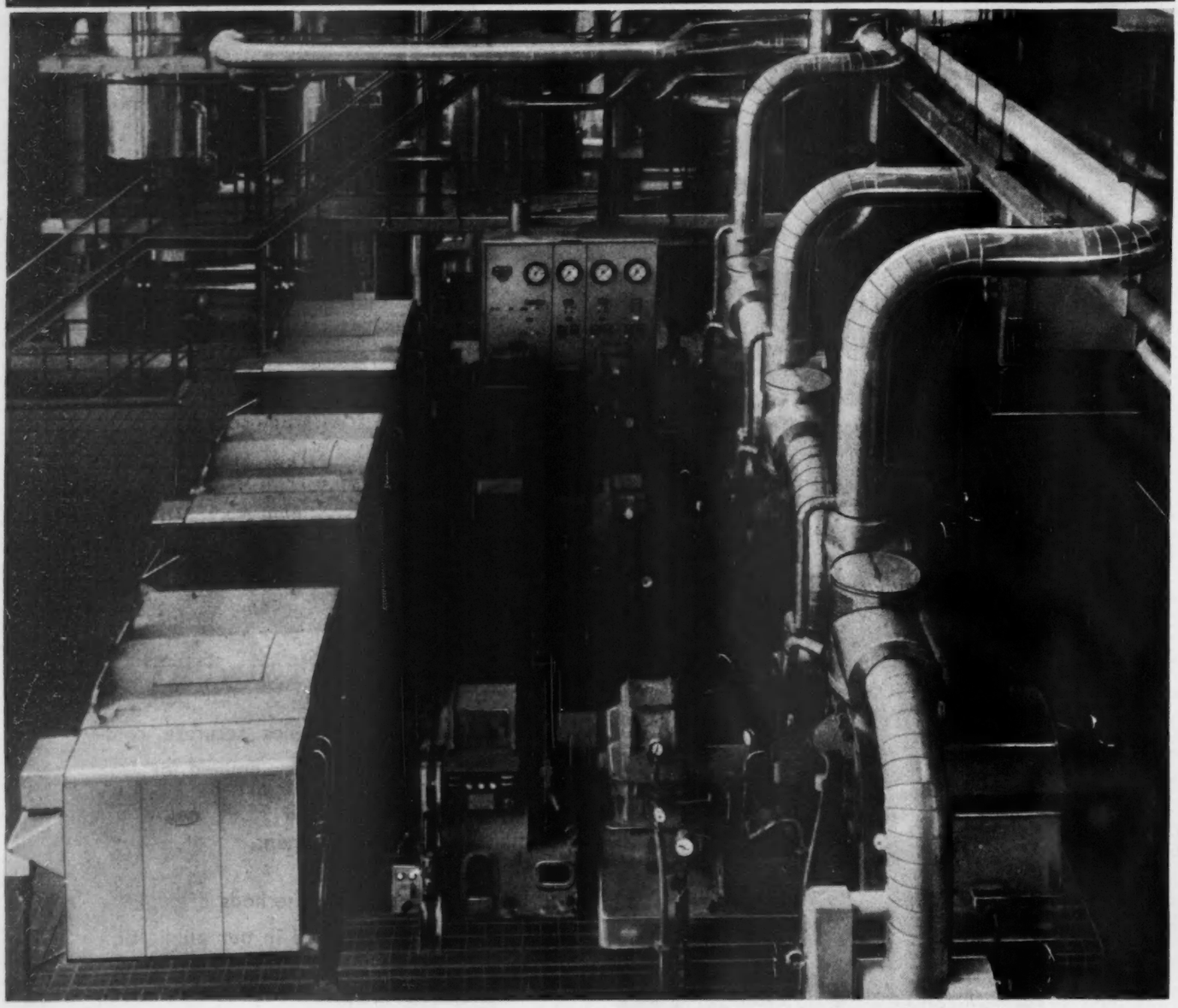

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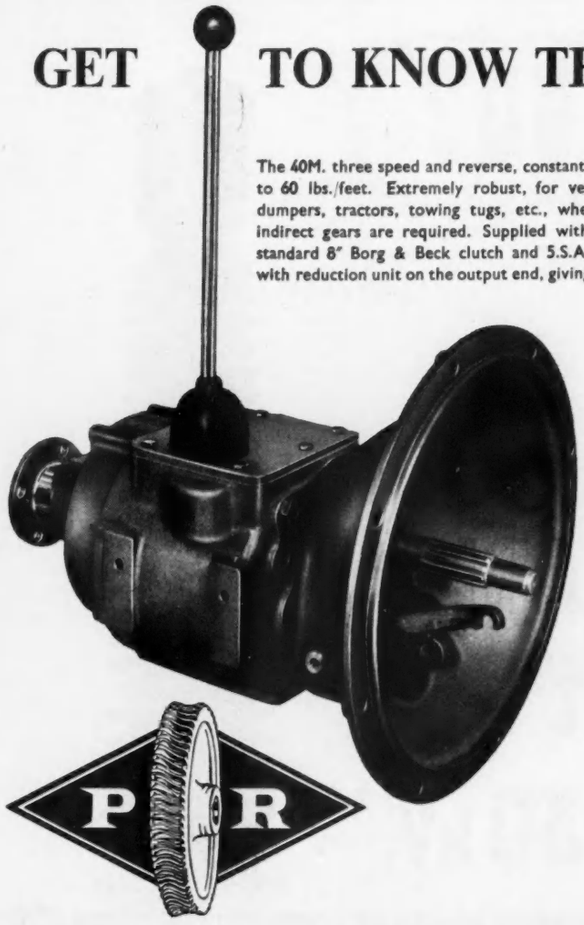

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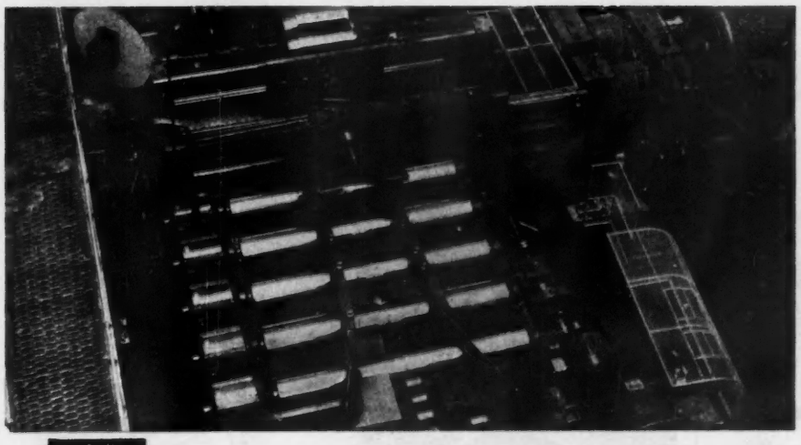


Armourchromed Rolls, over 11ft long, in use at Banbury.
Photograph by courtesy of The Northern Aluminium Co. Ltd.

ARMOURCHROME will increase the working life of Rolls, Die-Sets and Press Tools several times. Be sure your NEW equipment is pre-treated with this cost-cutting, ultra-durable process and remember that worn, rejected components can be reclaimed by the application of ARMOURCHROME. Approved by A.I.D. Test House and the various Ministries, ARMOURCHROME provides a VDH rating of approximately 900, helps to eliminate scoring, roll marks and other blemishes from the finished job besides giving protection from deterioration in storage. Ask our Technical Sales Department for further details NOW !

Scientific Control

Skilled Technique

The Power behind ARMOURCHROME

Precision Inspection

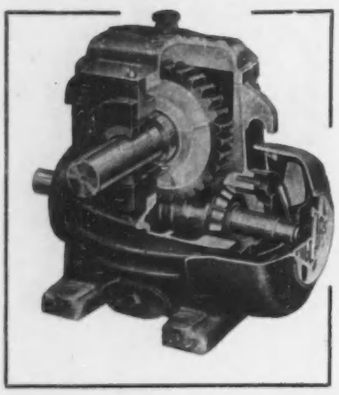
THE BRIGHTSIDE PLATING COMPANY LTD.,

Brearley Street · Birmingham 19 · *Tel: Aston Cross 2663*

Enter No. 1112 on reply card

CHECK!

"HIGHFIELD FANCOOL"



Range of SPEED REDUCING UNITS to B.S. 3027: 1958 Standards now available

This range of gear units has been designed in co-operation with the British Gear Manufacturers Association and also The Engineering Equipment Users Association to provide a range of gear units standardised in overall dimensions with other gear manufacturers, yet maintaining our special features for providing the most efficient speed reducer of this type.

The "Highfield Fancool" Range consists of three sizes 4", 6" and 8" centres and is in addition to our other standard ranges. All are available for early delivery.

May we send literature?

HIGHFIELD HIGEARS

GEAR & ENGINEERING CO. LTD.

NILE STREET, HUDDERSFIELD
TELEPHONE: HUDDERSFIELD 4490 (3 lines) TELEGRAMS: HIGEARS HUDDERSFIELD

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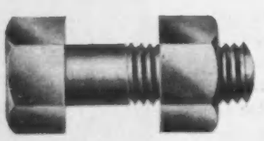
nuts

bolts

washers



Cooper nuts, bolts and studs are made to British Standard specifications or variations according to customers' requirements.
Large stocks are carried for quick delivery.

GEORGE COOPER & SONS
PROPRIETORS THOS. W. WARD LTD.
EFFINGHAM NUT & BOLT WORKS
PHONE 41026 SHEFFIELD GRAMS "COOPER"

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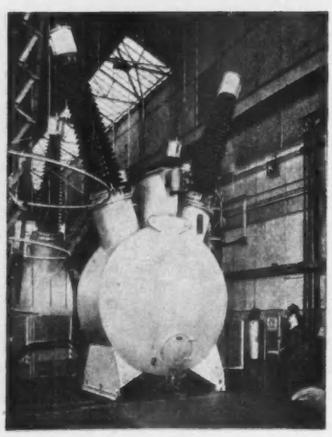
KARIBA at 330 kV.

All the bushing porcelains for the 330 kV. circuit breakers
All the 330 kV. strain insulators for the substations
and the 330 kV. post insulators for some of the substations by

BULLERS

MAIN CONTRACTORS · B.T.H. Co. Ltd.
Consulting Engineers · Merz & McLellan



The illustrations show a complete 330 kV. bushing insulator and a 330 kV. circuit breaker, by courtesy of the B.T.H. Co.

A·S·E·E
ELECTRICAL ENGINEERS EXHIBITION
EARLS COURT APRIL 5th – 9th
VISIT US ON STAND W.3

BULLERS LIMITED · MILTON · STOKE-ON-TRENT · STAFFS
Telephone: Stoke-on-Trent 54321
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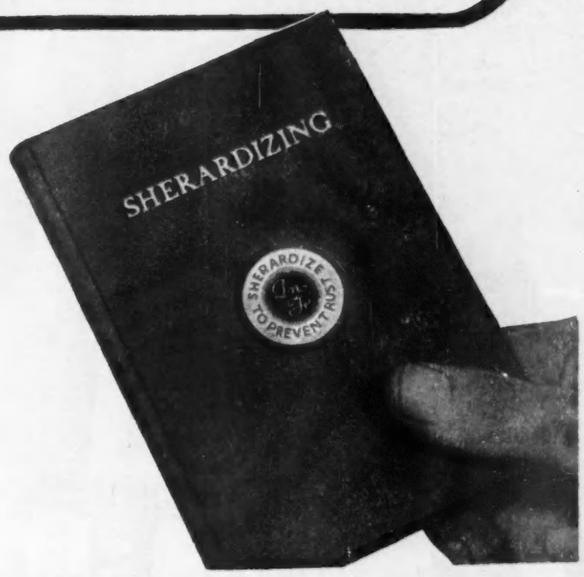
YOURS *for the Asking*

LEARN HOW TO—

SPECIFY

TEST

USE



SHERARDIZING

ZINC ALLOY RUST PROOFING Co. Ltd.

SHAKESPEARE STREET WOLVERHAMPTON
Telephone: Wolverhampton 27531 (5 lines)

And at LONDON and ROCHDALE

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These premises for Brocklehurst Motors Ltd. of Chesterfield, clearly demonstrate that KARISCOL buildings are the ideal prefabricated structures where spacious, well-lit floor areas are required. Clear spans range from 30ft. to 100ft. and the portal frame design ensures the best possible use to be made of the building height without interference from conventional roof trusses. The KARISCOL patent joint at eaves and apex reduces site bolting to a minimum and therefore speeds erection and lessens cost. Buildings can be supplied in any multiple of 12ft. 6in. in length and alternative eaves heights are available for all spans. Extensions can be added easily to sides or ends, as required. Crane gantries can also be incorporated for overhead electric or hand operated cranes up to 5-ton capacity. For further information write to Lilleshall for literature Ref. K108.

choose Kariscol
LESS TIME LOWER COST BUILDINGS

THE LILLESHALL COMPANY LIMITED
St. George's, Oakengates, Shropshire.
Telephone: OAKENGATES 120.
Telegrams: LILLESHALL OAKENGATES.

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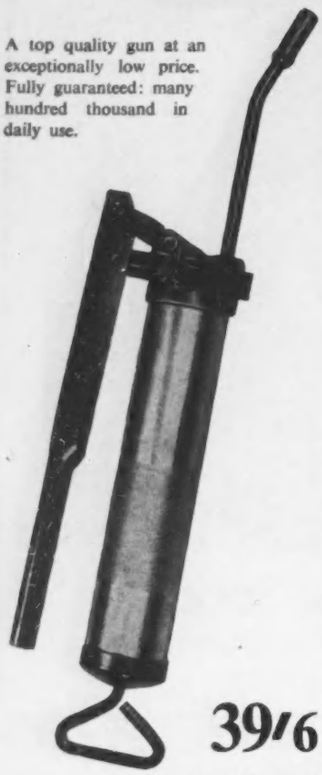
SWEMATIC HIGH PRESSURE GREASE GUN

A top quality gun at an exceptionally low price. Fully guaranteed: many hundred thousand in daily use.



39/6

Complete with cranked extension pipe and hydraulic chuck, as illustrated.

★ The ideal gun for garage and workshop use. ★ Easy operation of the side lever gives pressures exceeding 6,000 lb. p.s.i. ★ For oil (SAE 90 or heavier) and all grades grease. ★ 16 oz. capacity. ★ Suction loading. ★ Valve to release airlocks ★ All parts replaceable. ★ Black oxide and nickel finish. ★ Special terms for quantities.

HYDRAULIC GREASE NIPPLES

Made to British Standards and interchangeable with other makes. Available in bulk or in handy assortments of all popular sizes. Very keen prices.

LAWRENCE EDWARDS & CO. (ENGINEERS) LIMITED

KIDDERMINSTER, WORCS.

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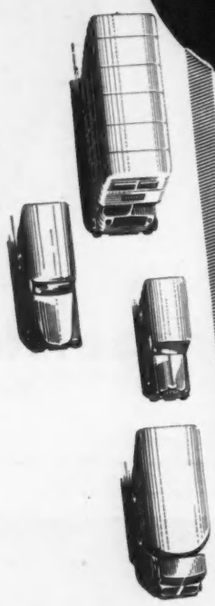
G.E.C. 'THREE EIGHTY' LANTERN *for MAIN ROAD lighting*



The lantern, which has been designed for use on main roads, houses three 5 ft. 80 watt Osram fluorescent tubes. Among the entirely new features of this lantern are :—

- Side entry mounting, the bracket being concealed within the lantern body.
- Modern body design incorporating concealed hinges and catches supporting the " Perspex " enclosure.
- Optical control obtained by " Perspex " refractor plates bonded one to each inner side of a " Perspex " bowl.
- Tube operating gear housed within the lantern body.
- Hinged top to the body enabling the tube operating gear to be examined the right way up.

THE GENERAL ELECTRIC CO. LTD. · MAGNET HOUSE · KINGSWAY · LONDON · W.C.2

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May we pick the winner for you . . .

When choosing between Die Castings or Hot Pressings you can count on us for sound, unbiased advice! We make both HOT PRESSINGS in *Brass, Bronze, Copper or Aluminium* and GRAVITY DIE CASTINGS in *Brass, Bronze, or Aluminium.* The unique experience of our organisation . . . two separate yet inter-related operations under one roof . . . will ensure that your choice is correct. For a constant or phased supply of DIMENSIONALLY ACCURATE PARTS in *Brass, Bronze, Copper or Aluminium*—see us first! Our Technical Representatives are always at your service.

BRASS PRESSINGS (LONDON) **LTD.**
THE NON-FERROUS DIE CASTING CO. LTD.

Non-Ferdica Works, North Circular Road, London, N.W.2. Tel: GLAdstone 6377 1732A

The choice is often difficult

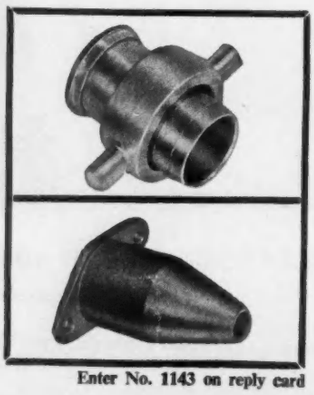

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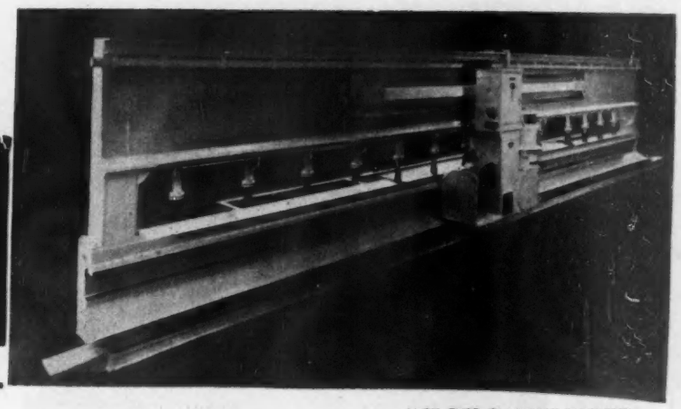
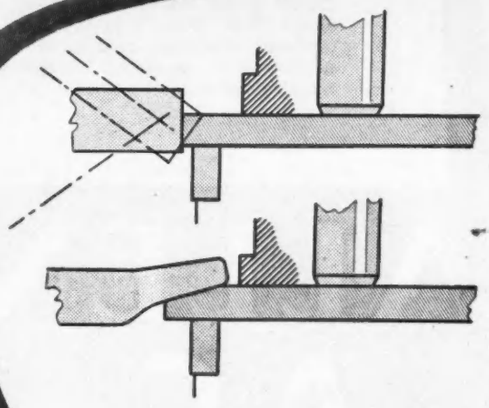
PLATE EDGE PLANING AND ROTARY SHEARING



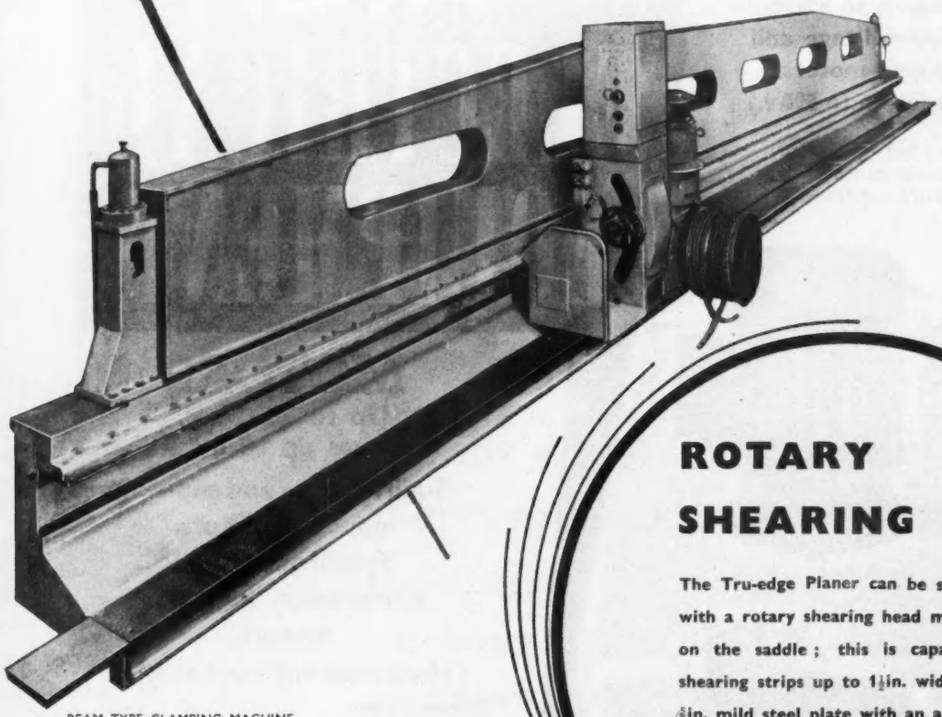
JACK TYPE CLAMPING MACHINE



SQUARE · BEVEL · LONG BEVEL
with speed and efficiency on the

HUGH SMITH TRU-EDGE PLANER

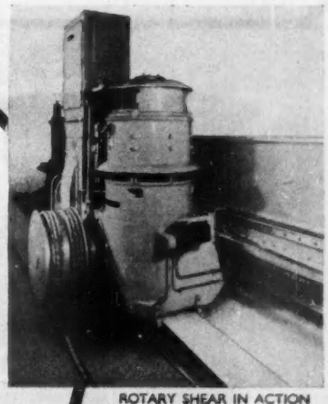
This planer, made in lengths of 25, 30, 35 and 40 feet, handles plates up to 2in. thick with speed and accuracy, and where thicker plates, or bundles of plates, require edge planing we can provide a motorised tool box with a vertical rise of 6in. for progressive planing. Profile tools can be used in either case, or swivelling action can be provided for planing top and bottom bevels up to 35 deg. above or below the centre line. A special planing tool is available for cutting long bevels. In design and construction the Tru-edge Planer is highly modern in every respect and it will provide many years of excellent service. We will be pleased to supply technical information.



BEAM TYPE CLAMPING MACHINE

ROTARY SHEARING

The Tru-edge Planer can be supplied with a rotary shearing head mounted on the saddle; this is capable of shearing strips up to 1½in. wide from ⅜in. mild steel plate with an accuracy of 0·01in. in 40 feet. Its operation is about forty times faster than gas cutting, and less expensive.



ROTARY SHEAR IN ACTION

SHOWING ROTARY SHEAR WHEEL AND PLANING TOOL BOX

HUGH SMITH & CO. (POSSIL) LTD.
HAMILTONHILL ROAD, GLASGOW, N.2.
Telephone: POSSIL 8201/3 *Telegrams: "POSSIL, GLASGOW"*

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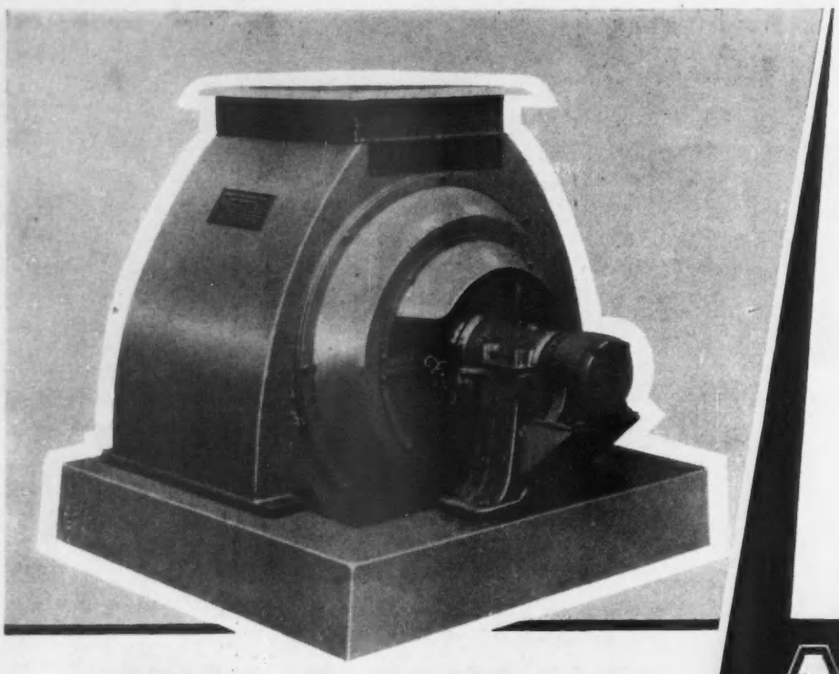


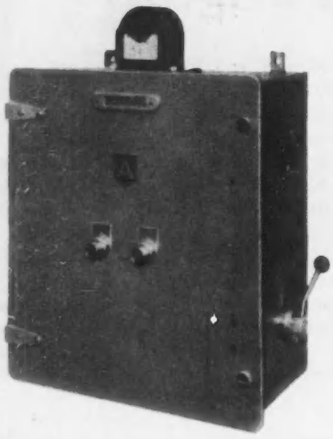
ALTERNATORS

Up to 3500 kW : 6·6 kV

Rotating field and revolving armature types. Also self-regulating type with static excitation and control equipment.

Illustrated (left)
350 kW, 0·8 p.f., 440 volt, three phase, 60 c/s, 1800 r.p.m., drip-proof self-regulating alternator, complete with overhung-rotor permanent magnet initiation exciter.

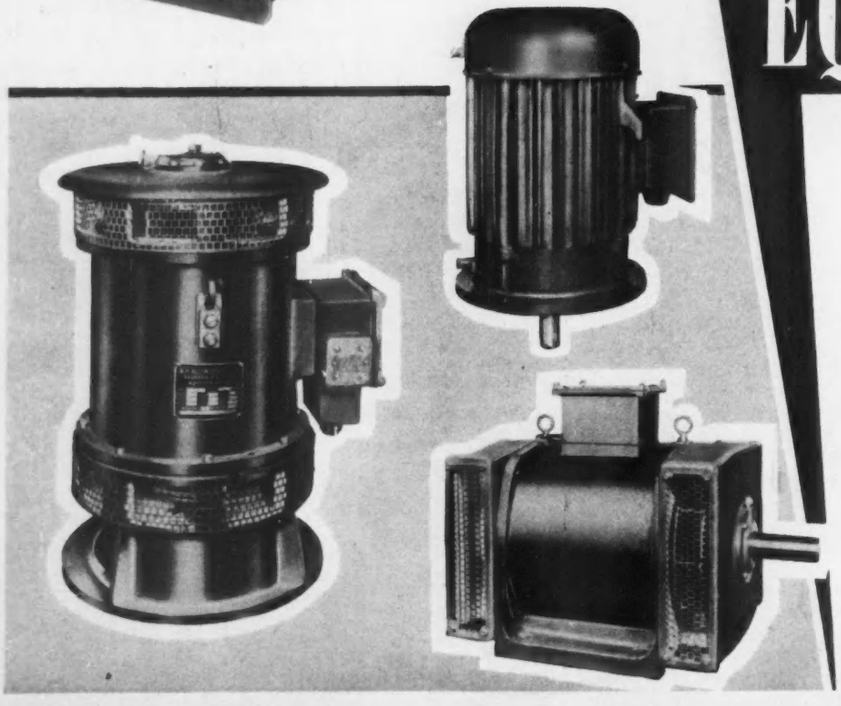
ALLEN A.C. ELECTRICAL EQUIPMENT



CONTROL GEAR

Automatic air-break contactor-type starters for squirrel-cage and slip-ring motors. (voltages up to 500 v.)

Illustrated (left)
Direct-on-line starter for three-phase squirrel-cage motor.



MOTORS

Up to 2000 h.p. (voltages up to 6·6 kV)

Squirrel-cage and slip-ring induction motors. Synchronous and synchronous induction motors.

Horizontal and vertical types

Illustrated (left)
Vertical, enclosed ventilated, drip-proof motor.

Vertical, totally-enclosed, frame-cooled, squirrel-cage induction motor.
Horizontal, enclosed ventilated motor.

We invite your enquiries

W. H. ALLEN SONS & Co LTD BEDFORD

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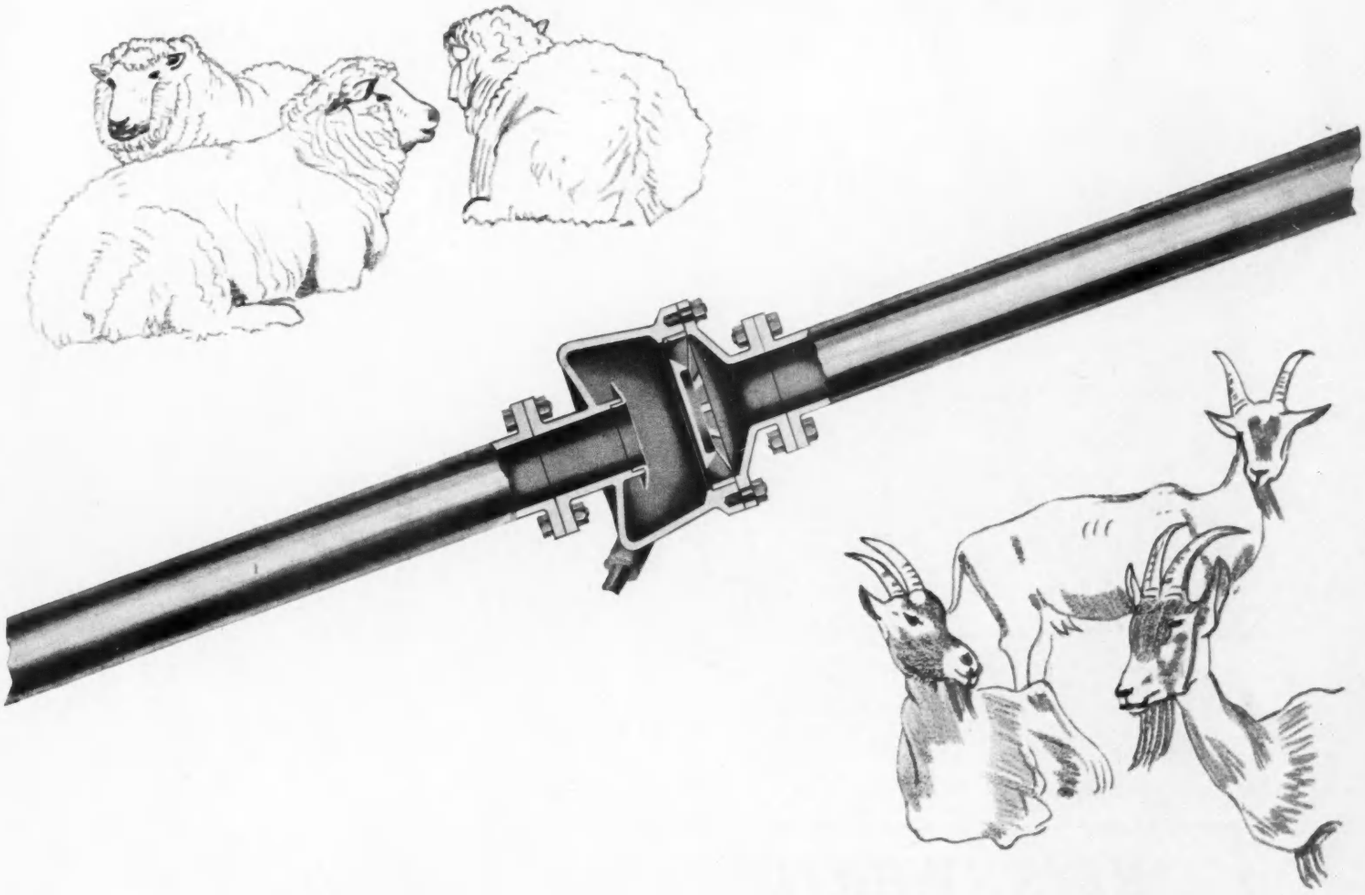
Sheep and goats!
Oil and Water!
it's all a matter of separation



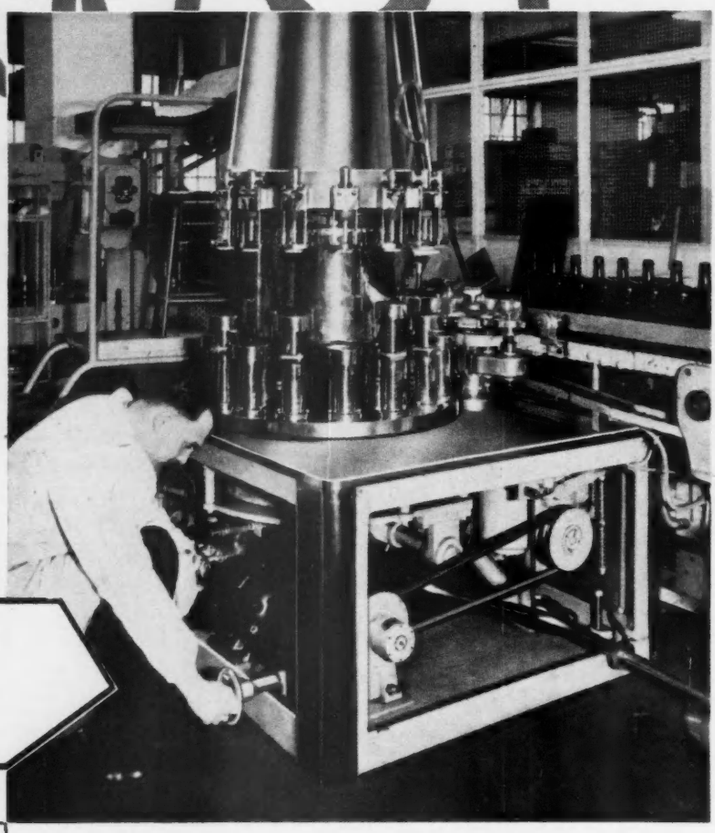
We cannot deal with sheep or goats, but the 'Supreme Vortex' pipe line separator is unsurpassed for separating . . . .

Moisture **and oil drops from compressed air**
Moisture **from steam**
Dirt particles **from gases**

carruthers
SEPARATOR DIVISION

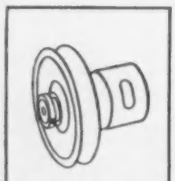
J. H. CARRUTHERS & CO. LTD., COLLEGE MILTON, EAST KILBRIDE, GLASGOW.
Telephone: East Kilbride 20591
Telegrams: 'Hoisting' East Kilbride
Enter No. 1171 on reply card

SLOW SLOW—QUICK—QUICK SLOW



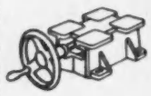
If product flow goes quick, quick slow—then what you need is variable speed. 2400 bottles for gin—Gordon's of course—reach this machine every hour, but there can be 3600. The gin is there, so the machine must bottle faster. How? Turn the handwheel and the Hainsworth pulley and V-belt move to the right speed position automatically. Faster—slower—every few minutes if needed. Bottling, spinning, woodworking, packaging—give your production a tonic, and get the right speed for your need with . . .

'HAINSWORTH' VARIABLE SPEED DRIVES



THE PULLEY
7 sizes available for drives up to 10 H.P.

THE V-BELT
one of 35 sizes will suit your job



THE CONTROLLER
will carry any standard electric motor

Send for Catalogue 100/19

Fenner

J · H · FENNER & CO LTD, HULL

Stocks carried in BELFAST. BIRMINGHAM. BRADFORD. BRISTOL. BURNLEY. CARDIFF. GLASGOW HULL. LEEDS. LEICESTER. LIVERPOOL. LONDON. LUTON. MANCHESTER MIDDLESBROUGH. NEWCASTLE. NOTTINGHAM. SHEFFIELD. STOKE.

LARGEST MAKERS OF V-BELT DRIVES IN THE COMMONWEALTH

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Rolled Rings

For Aircraft Nuclear and other Engineering purposes

Rolled Rings in Carbon, Alloy and Special Steels for the Aircraft, Electrical, Nuclear Power, Ball Bearings and General Engineering Industries.

by FIRTH BROWN

ALLOY STEELMAKERS · FORGEMASTERS · STEEL FOUNDERS · HEAVY ENGINEERS

THOS. FIRTH & JOHN BROWN LIMITED · SHEFFIELD · ENGLAND

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CLASSIFIED ADVERTISEMENTS

PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS

Lineage Rate. 4/6 per line of approximately 6 words. Minimum 18/-. **Inch Rate.** 54/- per single column inch and pro rata. 12 lines to 1 inch.
There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-. **Inch Rate.** 48/- per single column inch and pro rata. 12 lines to 1 inch.
There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an Illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

***Advertisements for publication should be addressed to :*—Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY, ST. JOHN STREET, LONDON, E.C.1

LECTURER AND SENIOR LECTURER

Applications are invited for appointments as LECTURER and SENIOR LECTURER in the Department of Civil and Mechanical Engineering, dating from September, 1960, or earlier, in regard to the following subjects : Mechanics of Machines, Applied Thermodynamics, Strength and Properties of Materials, Mechanics of Fluids.

Applicants should be qualified to teach in courses for the Engineering Degree and Diploma in Technology and for Senior Lectureships should be able to make some contribution at post-graduate level in teaching or taking charge of research projects. Facilities are available for research by members of staff. These appointments are additional to the present staff and arise from the rapid growth in the work of the College.

Salary scales : Lecturer, £1370, rising to £1550 ; Senior Lecturer, £1550, rising to £1750, plus in each case London Allowance of £38, rising to £51 at age 37.

Further particulars and forms of application are obtainable from the Secretary, to whom applications should be sent by 21st March, 1960. E9030

ROYAL MILITARY COLLEGE OF SCIENCE

SHRIVENHAM, BERKS

RESEARCH CHEMIST

Royal Military College of Science, Shrivenham, Berks, requires RESEARCH CHEMIST for two-year research programme in study of modification of organic materials by electrical discharges. Duties include design and construction of vacuum systems, preparing samples for test and analysis of products. Appointment as Scientific Officer, Experimental Officer or Assistant Experimental Officer with salary up to £1090 (S.O.), £1166 (E.O.), or £830 (A.E.O.), grading and starting pay according to age and qualifications. Qualifications required : S.O.—2nd Class Honours degree ; E.O. and A.E.O.—G.C.E. at "A" level in two or more subjects, or H.N.C. or equivalent. Quarters available for single man ; possibility of house for married man. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting reference F.106/OA. Closing date 18th March, 1960. E9088

UNIVERSITY OF LEEDS

DEPARTMENT OF ELECTRICAL ENGINEERING

LECTURER

Applications are invited for appointment as LECTURER in the Department of Electrical Engineering. Candidates should have good academic qualifications and experience in the field of electric power engineering, preferably electrical machines. Salary will be on the scale £900 by £50 to £1350 (efficiency bar) by £75 to £1650 a year. Applications (three copies) stating date of birth, qualifications and experience, together with the names of three referees should reach the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained) not later than 4th April, 1960. E9101

SURREY EDUCATION COMMITTEE

WIMBLEDON TECHNICAL COLLEGE, GLADSTONE ROAD, S.W.19

GRADE "B" ASSISTANT

GRADE "B" ASSISTANT required September, mainly to teach ENGINEERING DRAWING in Ordinary National and Machine Shop Engineering Courses. Preference to candidates with good Drawing Office experience and knowledge of Workshop Technology, who are corporate members of Institution of Mechanical Engineers. Salary, Burnham Technical Scale, plus London Allowance.

Application form and further particulars obtainable from Principal, to be returned by 18th March, 1960. E9079

PUBLIC APPOINTMENTS

GUILDFORD, GODALMING AND DISTRICT WATER BOARD

(AMENDED ADVERTISEMENT)

APPOINTMENT OF ENGINEERING STAFF

Applications are invited for the following appointments :

(a) ENGINEERING ASSISTANT (Capital Works). (Non-established Post.) A.P.T. IV (£1065–£1220 per annum).

(b) SENIOR ENGINEERING ASSISTANT (Established Post). Special Grade (£785–£1070 per annum).

Commencing salaries in accordance with qualifications and experience.

Candidates for post (a) should have had good experience in the design and construction of Capital Works, preferably on water supply schemes. A practical knowledge of water retaining structures, including the preparation of drawings and contract details, would be an advantage.

Candidates should be Associate Members of the Institution of Civil Engineers.

Candidates for post (b) should have had good experience in the general work of a Water Undertaking and have passed Parts I and II of the Associate Membership Examination of the Institution of Civil Engineers.

Both appointments will be subject to the National Scheme of Conditions of Service, the Local Government Superannuation Acts, and to the passing of a medical examination.

Applications, stating age, training, present and previous appointments and experience, and names and addresses of two referees, must be received by the Chief Engineer, "Branksome," Filmer Grove, Nightingale Road, Godalming, not later than Monday, the 14th March, 1960.

Housing accommodation will be made available if required.

Car allowance payable on "Casual User" basis.

H. C. WELLER, LL.B.,
Clerk to the Board.

Municipal Offices,
High Street,
Guildford. E9029

SOUTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

REGIONAL ENGINEER'S DEPARTMENT

SENIOR ASSISTANT ENGINEERS

Applications are invited for the following appointments on the permanent staff of the Board generally in accordance with the Whitley Council conditions of service.

SENIOR ASSISTANT ENGINEERS (Heating and Ventilating) :

The commencing salary will be at the minimum of the scale £1050 by £30 (3) by £35 (3) to £1245 p.a., plus London Weighting allowance of £50 p.a. (Scale under review). Applicants should be Corporate Members of the Institution of Mechanical Engineers and should be experienced in the preparation of specifications, drawings and estimates for large engineering installations in hospitals and large public buildings.

Applications stating age, qualifications, experience, present appointment and salary, together with the names and addresses of three referees should be sent to the undersigned at 40, Eastbourne Terrace, London, W.2, by not later than 20th March.

E. G. BRAITHWAITE,
E9120 Secretary.

KINGSTON GROUP HOSPITAL MANAGEMENT COMMITTEE

SENIOR ENGINEER

SENIOR ENGINEER, Kingston Hospital, Kingston-upon-Thames.

Applications are invited for above appointment under direction of Superintendent Engineer, from suitably qualified persons.

Salary : £770 by £25 (1) by £30 (4) to £915 per annum, plus London Weighting. Residence available at reasonable rental. Candidates must have served an apprenticeship and possess a sound knowledge of the operation of steam boiler plant, oil-firing and engineering services.

Details of age, qualifications and experience, together with names of two referees, to be sent within 14 days to the Group Secretary, Kingston Group Hospital Management Committee, 35, Coombe Road, Kingston-upon-Thames, Surrey. E9071

PUBLIC APPOINTMENTS

SHEFFIELD CORPORATION WATERWORKS

YORKSHIRE DERWENT SCHEME

TWO CHIEF ASSISTANT ENGINEERS

Applications are invited for the following appointments on the staff of the Waterworks General Manager and Engineer (A. B. Baldwin, M.Eng.) :

TWO CHIEF ASSISTANT ENGINEERS i/c. Sub-sections, J.N.C. Scale "A" salary : £1215 to £1445.

Successful applicants will be engaged upon the design and construction of the works of the Yorkshire Derwent Scheme, comprising a river intake and treatment plant, a 40-mile aqueduct, service reservoirs, pumping stations and plant.

Applicants must be Chartered Engineers experienced in the design and construction of major works, and previous employment on similar water supply schemes would be an advantage.

Appointments are superannuable and subject to medical examination and to the National Conditions of Service as applied by the City Council.

Applications, stating age, qualifications, present and past appointments (with dates and salaries), details of relevant experience and schemes engaged upon, and quoting the names and addresses of two referees, should reach the undersigned not later than the 12th March, 1960.

JOHN HEYS,
Town Clerk.

Town Hall,
Sheffield, 1. E9013

AIR MINISTRY

LONDON AND PROVINCES

ENGINEERING DESIGNER DRAUGHTSMEN

Air Ministry Works Designs Branch requires in London and Provinces ENGINEERING DESIGNER DRAUGHTSMEN experienced in preparation of pipework and mechanical and electrical plant layouts. Candidates should have served recognised apprenticeship or had equivalent training and also have had practical experience. O.N.C. an advantage. Financial assistance and time off given for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days' leave per year initially. Overseas tours for which special allowances granted.

Salary in London ranges from £680 (at age 25) to £900 per annum for men ; from £673 to £868 per annum for women. Somewhat lower in Provinces. Commencing salary dependent on age, qualifications and experience.

Applicants, who must be natural born British subjects, should write to Air Ministry, W.G.c, Lacon House, Theobalds Road, London, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3743), giving age, details of training, qualifications, full particulars of former posts held, and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. E8431

CITY OF SHEFFIELD

SEWAGE DISPOSAL DEPARTMENT

GENERAL MANAGER

Applications are invited for the appointment of General Manager of the Sewage Disposal Department, at a salary of £2325 per annum, rising by four annual increments of £60 and a final increment of £45 to £2610 per annum. (J.N.C. Scale I.)

Applicants should have had considerable experience in the administration of a large Sewage Disposal Department, and should be suitably qualified engineers or chemists.

The person appointed will succeed Mr. J. H. Edmondson, M.I.Mech.E., M.I.Chem.E., and will be required to devote his whole time to the duties of his office.

The appointment is subject to a medical examination, superannuation, three months' notice on either side, and the conditions of service of the J.N.C. for Chief Officers of Local Authorities.

Applications, which must be made on the official form, obtainable from me upon request, must reach me on or before 18th March, 1960.

Canvassing in any form will disqualify.

JOHN HEYS,
Town Clerk.

Town Hall,
Sheffield, 1. E9026

PUBLIC APPOINTMENTS

REPUBLIC OF THE SUDAN

ENGINEER—GINNING FACTORIES

Applications are invited from those suitably qualified to fill a vacancy of ENGINEER—GINNING FACTORIES with the Sudan Gezira Board.

Applicants must have served a recognised apprenticeship or a course of training in engineering and have had several years experience in the maintenance of electric motor-driven textile plant, hydraulic equipment, fans, &c. A knowledge of maintenance and operation of 250/300 b.h.p. Diesel Engines is desirable. Possession of H.N.C. or equivalent would be an advantage.

Appointment will be on contract for a period of three years in the salary range £S.1000 to £S.1500. A gratuity representing one-fifth of total basic salary received will be paid on the satisfactory completion of the contract. A cost of living allowance is payable and an initial outfit grant of £S.60 is paid on appointment. Free accommodation with electricity and water is provided by the Board. Annual leave is 60 days. There is no income tax payable in the Sudan at present.

Applications in writing giving fullest details of qualifications and experience and age with copies of two recent testimonials to :

Appointments Section, Sudan Embassy, Cleveland Row, St. James's, London, S.W.1. Closing date, 15th March, 1960. Quote reference L.E.7-4/2420. E9104

LEICESTER ROYAL INFIRMARY

ASSISTANT ENGINEER

Applications are invited for the post of ASSISTANT ENGINEER. Salary (at present under review) on the scale £575–£700. The successful applicant will be directly responsible to the Superintendent Engineer and may either be required to take direct charge of the maintenance and operation of the engineering plants of several small hospitals, or to assist the Senior Engineers at the larger hospitals in the Group. He will be required with other engineers, to take part in an "On Call" rota. Applicants must have completed an apprenticeship in, or have a sound practical knowledge of, mechanical engineering. Preference will be given to applicants with the O.N.C. in Mechanical Engineering, which includes heat and heat engines. There is no accommodation available. Applications, stating age, qualifications and experience, together with names of three referees (who should be present and/or past employers) to the Group Secretary, The Leicester Royal Infirmary, within fourteen days of this advertisement. E9063

CIVIL SERVICE COMMISSION

MECHANICAL AND ELECTRICAL ENGINEERS

Pensionable posts for men and women normally under 35 on 1st March, 1960. Applicants must normally have degree in engineering or physics (or Dip. Tech. for some posts) or have passed examinations necessary for A.M.I.Mech.E., A.M.I.E.E., A.F.R.Ae.Soc., etc. Exceptionally, evidence of high professional attainment acceptable in lieu. Practical training and experience required, but untrained graduates acceptable for some posts. Men's starting salary (London) from £830 (lower if under 25) to £1125. Maximum £1300. Promotion prospects. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S/85/60. Closing date 30th March, 1960. Earlier applicants may be interviewed before that date. E9089

MINISTRY OF TRANSPORT

CIVIL ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on 1st January, 1960 (extension for regular Forces service, Overseas Civil Service, established civil service, and temporary Government service as Civil Engineer). Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining such membership. Experience in road and bridge construction essential ; knowledge of Highways Authorities' procedure desirable. Starting salary (men, London) from £830 to £1125, according to age. Scale maximum (London) £1300. Promotion prospects. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S/64/7. E9111

PUBLIC APPOINTMENTS

MINISTRY OF LABOUR

ADMIRALTY NAVY WORKS DEPARTMENT

MECHANICAL ENGINEERS

Admiralty Navy Works Department require MECHANICAL ENGINEERS at Pinner (Middlesex) and Portsmouth, Liverpool, Glasgow and Rosyth. Qualifications : Corporate Members of Institution of Mechanical Engineers. Work comprises design and supervision of mechanical services in Admiralty Shore Establishments (except Royal Dockyards) such as Heating, Ventilating, Air Conditioning, Cranes, Machine Tools, Civil Engineering Plant, &c. Candidates, should be at least 32 years of age, and have experience in this or similar work. Salary range from £1285 to £1730 (National Rate), rates vary slightly according to location. Appointments unestablished but opportunities later for establishment. Prospects of promotion and opportunities for service overseas. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C.190/OA. Closing date 25 March, 1960. E9112

THE ROYAL COLLEGE
OF
SCIENCE AND TECHNOLOGY
GLASGOW

(In affiliation with the University of Glasgow)

DEPARTMENT OF MECHANICAL, CIVIL AND CHEMICAL ENGINEERING

LECTURER

IN

STRENGTH OF MATERIALS

Applicants should possess Honours Degree in Engineering or Applied Mathematics, an interest in elasticity and stress analysis techniques and experience in the use of photo-elastic techniques an advantage. Excellent research facilities for a higher degree.

Salary on scale £900 by £50 to £1350 by £75 to £1650, plus F.S.S.U. and Family Allowances.

Application forms obtainable from the Secretary, George Street, C.1.

E9091

TENDERS

FORTH ROAD BRIDGE

CONTRACT NO. 3

(ROAD WORKS SOUTH OF FIRTH OF FORTH)

TENDERS are invited from experienced Contractors for the execution of work comprising—

(1) Approximately 3 miles of dual-carriageway approach roads ;

(2) Seven reinforced concrete or steel bridges ; and

(3) Reinforced concrete abutments.

Copies of the Contract Documents and Drawings may be obtained from the Consulting Engineers, Messrs. Mott, Hay & Anderson, 14, Melville Street, Edinburgh, 3, on payment of a deposit of £10 by cheque made payable to the Forth Road Bridge Joint Board. The deposit will be repayable when a bona fide tender has been received.

Tenders must be sent in sealed plain cover marked "Tender for the Forth Road Bridge Contract," and addressed to The Clerk, The Forth Road Bridge Joint Board, City Chambers, Edinburgh, so as to be received there not later than 19th April, 1960.

The Joint Board do not bind themselves to accept the lowest or any Tender.

W. BORLAND,
Clerk to the Forth Road Bridge Joint Board.
E9055

SOUTHPORT AND DISTRICT WATER BOARD

SCARISBRICK WATERWORKS—CONTRACT No. 20

PUMPING PLANT, OIL ENGINE AND ELECTRICAL PLANT, &c.

TENDERS are invited from manufacturers for SUPPLYING and ERECTING TWO ELECTRICALLY DRIVEN VERTICAL SPINDLE BOREHOLE PUMPS and THREE SURFACE PUMPS, ONE OIL ENGINE and ALTERNATOR, CRANES, ELECTRIC MOTORS and CONTROL GEAR, &c., at Mill Brow Pumping Station, Southport Road, Scarisbrick, Nr. Ormskirk.

The Tender Form, Conditions of Contract, Specification and Drawings will be supplied by the Engineer and Manager, 14, Portland Street, Southport, on depositing Three Guineas.

Tenders must be delivered to the undersigned at the Town Hall, Southport, not later than first post on Saturday, March 26th, 1960.

R. EDGAR PERRINS,
Clerk to the Board.
E9092

TENDERS

INDIA SUPPLY MISSION

THREE LIGHT DIESEL TRACTORS

The office of India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington 8, D.C., United States of America, invites TENDERS for the following :

TENDER ENQUIRY No. SE.141

For the SUPPLY of THREE LIGHT DIESEL TRACTORS for Hauling 7 tons Wheeled Loads over Rough Ground. Required by Neyveli Lignite Corporation Ltd., Madras, India.

Tender documents, &c., relative to the above can be obtained from the Co-Ordination Branch, India Store Department, Bromyard Avenue, Acton, W.3, at a cost of 14s. 3d. per tender, and is not refundable. Tenders are to be returned direct to the India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington 8, D.C., U.S.A., so as to reach them by the 1st April, 1960.

Specimen copy of the above enquiry can be seen at India Store Department, Vehicles Branch, Bromyard Avenue, Acton, W.3, under the following reference : S.4027/59/AKB/VEH. E9097

EDUCATIONAL

COLLEGE OF AERONAUTICS

ENGLISH ELECTRIC RESEARCH FELLOWSHIP IN AERONAUTICS

Applications are invited for a RESEARCH FELLOWSHIP which has been established at the College by the English Electric Company Limited. The Fellowship is intended to provide opportunity for postgraduate research into the problems of vibration or stability and control of aircraft and is tenable for one year beginning on or about 1st October, 1960. The value of the Fellowship is £750.

Applications giving full particulars of education and experience and quoting the names of three referees are required by 1st May, 1960, and should be addressed to—

The Warden,
The College of Aeronautics,
Cranfield,
Bletchley,
Bucks. E9102 E

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (UNIVERSITY OF LONDON)

POSTGRADUATE COURSE IN NUCLEAR POWER

A full-time postgraduate course in nuclear power is held each year at Imperial College. This course is conducted from the engineering point of view, and is intended primarily for Graduate Engineers and Applied Scientists who wish to pursue a career in the design, development and construction of nuclear power stations. A special feature of the course is the inclusion of a design study of a complete nuclear power project. Experimental work will include the use of a natural uranium-graphite exponential assembly.

Further information may be obtained on application to the REGISTRAR, IMPERIAL COLLEGE, LONDON, S.W.7. E9087 E

COLLEGE OF AERONAUTICS

Applications are invited for the PERRING SCHOLARSHIP in AERONAUTICS, valued at £500 per annum, tenable at The College of Aeronautics. The successful candidate will be admitted to the two-year course in Aeronautical Engineering and Science at the College, leading to the award of the College Diploma (D.C.Ae.).

Applicants should preferably be Honours graduates or final year undergraduates in engineering, mathematics or physics ; applications from non-graduates with comparable qualifications will also be considered. Candidates must be British subjects domiciled in the United Kingdom.

Forms of application and statement of conditions will be forwarded on written application to :

The Warden,
The College of Aeronautics,
Cranfield,
Bletchley,
Bucks.

The closing date for the receipt of applications is 18th May, 1960. E9103 E

COVENTRY TECHNICAL COLLEGE

COURSE ON "MODERN MATERIALS"

A Short Course for Chemists, Metallurgists and Engineers on the "PROPERTIES AND INDUSTRIAL APPLICATIONS OF MODERN MATERIALS," will be held on Thursday and Friday, March 31st and April 1st, 1960.

Course Fee : One guinea.

Particulars and application form from Head of Chemistry Department. E8897 E

IMPERIAL COLLEGE

BUSARIES in Highway Engineering provided by the Rees Jeffreys Road Fund, tenable from October, 1960. Value from £460 to £760 per annum, including fees.—Further particulars from the Registrar, Imperial College, London, S.W.7. Closing date April 8th, 1960. E9105 E

A.M.I.MECH.E., B.Sc., City and Guilds, etc. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free, on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A QUALITY CONTROLLER is required for a Company manufacturing Household Appliances in Central Scotland. The successful applicant will be a trained Engineer with sound experience in modern principles and practical application of Quality Control. He will be familiar with British Standard Quality Control Specifications and Statistical approach to Sampling Inspection. The Quality Controller will report directly to top Management and will be covered by Company Life Insurance and a Contributory Superannuation Scheme.—Replies will be treated in strict confidence and should be addressed to BOX No. E2733, "The Engineer." A

APPLICATIONS ARE INVITED from ambitious and resourceful men to fill the position of TECHNICAL ASSISTANT to the Sales Manager of Electric Lamp Machinery Manufacturers near London. A permanent progressive and interesting job is offered to the right person, who must possess a sound engineering and commercial background in the trade.—Applications, with full particulars of education, experience and salary required, to BOX No. E171, "The Engineer." A

ATOMIC ENERGY RESEARCH ESTABLISHMENT HARWELL

A TECHNICIAN

is required to supervise and organise the INSPECTION, INSTALLATION and MAINTENANCE of MECHANICAL PLANT associated with the 7 GeV PROTON SYNCHROTRON being built at Harwell for the National Institute for Research in Nuclear Science.

Applicants should have served an engineering apprenticeship or have had equivalent training. Experience in maintaining high vacuum equipment, air conditioning and water treatment plants an advantage. Possession of O.N.C. or equivalent desirable.

Salary : £925 (at age 30 or over) to £1105 p.a.

Housing and pension scheme.

Send POSTCARD for application form to Group Recruitment Officer (1617/25), U.K.A.E.A., A.E.R.E., Harwell, Didcot, Berks.

E9099 A

AUSTRALIA

Applications are invited for a DESIGN ENGINEER, with experience in the design of current and voltage transformers, at voltages up to and including 132,000 volts. Applicants should be in the 25/35 age group and possess a Degree in Electrical Engineering or H.N.C. Diploma. Housing will be provided to successful applicant. Salary in the £1500 year range. Write BOX No. 3123, c/o Charles Barker and Sons Limited, Gateway House, London, E.C.4. E9066 A

BRITISH INSULATED CALLENDER'S CONSTRUCTION CO. LTD.

have vacancies in their Overhead Line Contracts Department in London for :

ASSISTANT DESIGN ENGINEERS

Work involves structural design aspects of Electrical Transmission and Distribution Lines. Previous experience desirable, although not essential, but structural background up to H.N.C. standard an advantage. After appropriate training, successful applicants will be expected to conduct technical correspondence and negotiations. These posts carry progressive responsibility.

Attractive salaries will be offered to suitable applicants. Pension Fund ; Staff Canteen ; 5-day week.

Apply in writing, stating full details, to Staff Officer, above Company, at 30, Leicester Square, London, W.C.2. E9072 A

CEYLON EUROPEAN CONTROLLED COMPANY seek ELECTRICAL ENGINEER. Single preferred, 25–30 years of age, having sound technical and theoretical training. Higher National Certificate essential. Some experience in contracting overhaul and maintenance work. Three-and-half-year contract in first instance. Good salary and prospects.—Write, stating details, &c., to BOX No. Z.O.926, Deacons Advertising, 36, Leadenhall Street, London, E.C.3. E9109 A

CEYLON EUROPEAN CONTROLLED COMPANY seek MECHANICAL ENGINEER with sales experience, for large garage organisation. Single man, aged 25 to 30 years, preferred. Three-and-half-year contract in first instance. Good salary and prospects.—Write, giving details, &c., to BOX No. Z.P.927, Deacons Advertising, 36, Leadenhall Street, London, E.C.3. E9108 A

CHIEF DRAUGHTSMAN required by leading medium-sized Engineering Company specialising in Steel Fabrications. Applicant must have H.N.C. Mech. Eng., or be Corporate Member of Eng. Institute. Salary negotiable, commensurate with experience. Age 35–40. Contributory Pension Scheme. Own Staff advised.—Apply in confidence, with details of experience to Personnel Officer, Redheugh Iron & Steel Co. Ltd., Teams, Gateshead, 8, Co. Durham. E9059 A

Classified Advts. continued on page 122

BOOKS and PUBLICATIONS

KEMPE'S
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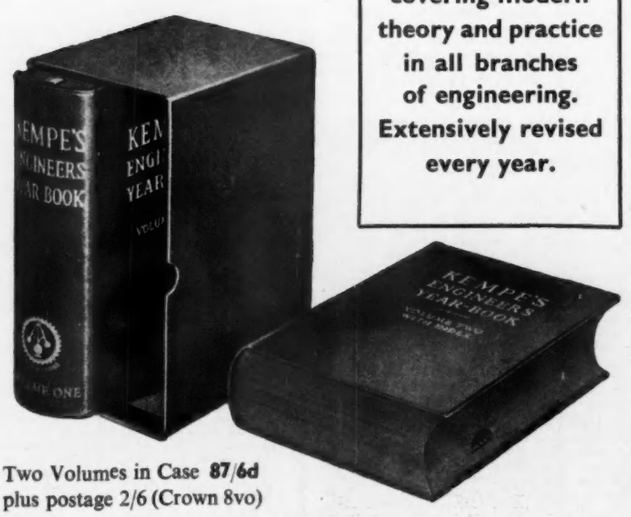
1960
EDITION

3,000 pages, 79 chapters covering modern theory and practice in all branches of engineering. Extensively revised every year.



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28 ESSEX STREET, STRAND, LONDON, W.C.2. Central 6565

Enter No. 1211 on reply card

SITUATIONS VACANT

DESIGN ENGINEERS AND DESIGNER DRAUGHTSMEN with up to seven years' experience in design of reinforced concrete and steel structures in connection with power stations, tunnels and railway works.—Apply, with details of experience, to Sir William Halcrow and Partners, Alliance House, Caxton Street, London, S.W.1. E9084 A

DEVELOPMENT ENGINEER

Williams (Hounslow), Ltd., Manufacturers of Dyestuffs, Fine Colours and Chemicals, require a qualified Engineer with experience of design and installation of chemical plant, to take charge of development of new projects.—Write, giving details of qualifications and experience, to Deputy Managing Director, 209, Hanworth Road, Hounslow, Middlesex.

E2746 A

DRAUGHTSMAN, Senior, Structural Steelwork experience.—Lindsay's Paddington, North Wharf Road, W.2 (Pad. 8485). E9107 A

DRAUGHTSMAN

Applications are invited for the above post, which is located in Birmingham.

The work is interesting and varied and is mainly in connection with the design of industrial heating equipment. A knowledge of combustion technique and the use of refractories would, therefore, be an advantage.

Candidates should possess the Ordinary National Certificate in Mechanical Engineering as a minimum qualification.

The salary for the appointment, which is pensionable and subject to medical examination, will be within the range of £733–£853 per annum.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston ,Birmingham, 15. E180 A

DRAUGHTSMAN—age 25/30—required for varied chemical plant development work. H.N.C. (Mechanical) and knowledge of plant layout and pipe work essential. Permanent and progressive post. Superannuation and profit sharing schemes.—Applications to : Personnel Manager, Messrs. F. W. Berk and Co., Ltd., Abbey Mill Chemical Works, Canning Road Stratford, E.15. E8990 A

DRAUGHTSMAN required by Gilbert Gilkes and Gordon, Ltd., for work on design of turbines, pumps and associated hydraulic equipment. Good working conditions—canteen, pension scheme and bonus scheme in operation.—Apply, giving full particulars, to Chief Draughtsman, Gilbert Gilkes and Gordon Ltd., Kendal, Westmorland. E8998 A

DRAUGHTSMEN required for Design and Development Work on Pneumatic and Electric Portable Power Tools. Interesting work, progressive and permanent positions. N.W. London area. —State age, experience and salary required to Head Designer, BOX No. E9045, " The Engineer." A

EDITORIAL ASSISTANT required for monthly journal specialising in world hydro-electric development. Should be young engineer (25–35), with qualifications and experience preferably in civil or hydraulic engineering or in laboratory work. Aptitude for technical writing essential. Some knowledge of languages an advantage. Prospect of eventual editorship for the right candidate.—Apply : The Editor, " Water Power," 33, Tothill Street, S.W.1. E9040 A

ENGINEER SALESMAN required for London area. Well-educated. Mechanical Engineer. Not more than 38 years of age. Required to sell pipework and general engineering products. Energetic and adaptable personality. Must have selling experience.—BOX No. E2736, " The Engineer." A

ERECTION MECHANICAL PLANT ENGINEER

responsible for inspection and maintenance of all mechanical construction plant, involving travel throughout the country (a car is provided). Age 28 to 35 with at least G.I.Mech.E.—Apply in detail, quoting this paper and reference 4/60A to The Staff Officer, WHESSOE LIMITED, Darlington. E9059 A

ENGINEERS, PHYSICISTS, CHEMISTS

The United Kingdom Atomic Energy Authority require the following staff at Dounreay Experimental Reactor Establishment, Thurso, Caithness, Scotland.

DESIGN ENGINEERS : to join a group of engineers engaged on the design and commissioning of experimental equipment for irradiation research in the materials testing reactor.

Applicants should have served a recognised engineering apprenticeship, be associate members of the Institution of Mechanical Engineers, or have equivalent qualifications. Several years' experience of design work, particularly in the field of light mechanical engineering, is also required. (Reference No. 174/31).

ENGINEERS, PHYSICISTS, CHEMISTS : to be responsible, on shift, for the operation of either the materials testing reactor or the fast reactor and its associated steam and electrical generating plant and experimental facilities.

Applicants for the engineering posts must have served a recognised engineering apprenticeship and be corporate members of a senior engineering institution, or have equivalent qualifications. For the physicist and chemist posts an honours degree together with at least 3 years' relevant industrial or research experience is the minimum qualification. (Reference No. 175/31).

Previous experience of atomic energy work is not essential and successful candidates will be given ample opportunity and assistance to familiarise themselves with any specialised knowledge required.

Salaries will be assessed, according to qualifications and experience, within the following ranges :

£860 (at age 25) to £1340 or £1370 to £1825.

Contributory superannuation. Staff housing scheme. Hostel accommodation available.

Send postcard for application form, quoting appropriate reference number, to Personnel Manager at above address.

Closing Date : 7th March, 1960. E9056 A

ENGINEERING CLERK OF WORKS COPTHORNE BARRACKS— SHREWSBURY

Applications are invited for an appointment as Mechanical and Electrical Clerk of Works in connection with these Services in 30 Married Quarters and for new buildings and modernisation of others at the Barracks.

The appointment will be on part-time basis for the Married Quarters and part or full-time on the Barracks.

The salary will be £850–£950 per annum (including subsistence). according to qualifications and experience ; the duration of the Contract will be about 2½–3 years.

Full particulars of previous experience and references should be sent to Messrs. Hoare, Lea and Partners, 23, St. James Road, Edgbaston Birmingham, 15, by 15th March, 1960. E9069 A

JOHN LAING AND SON LIMITED
require an
ASSISTANT MECHANICAL OR ELECTRICAL ENGINEER
in the Design Office at their Headquarters.

Applicants should be Associate Members or Graduates of their appropriate institution, and have design experience in Mechanical and Electrical Services to buildings.

The post is permanent and progressive. Five-day week. Superannuation scheme.—Apply, stating age, qualifications and experience to Personnel Manager (M.E.S.3), John Laing and Son Limited, London, N.W.7.

E9065 A

MECHANICAL ENGINEER : INDIA

Mechanical Engineer with electrical experience required for long-established Metalliferous Mine in India.

Corporate Membership of I.Mech.E. or of I.E.E. essential. Generous salary and allowances in keeping with experience. Excellent amenities, golf, tennis, swimming, &c.

Three-year tour normally includes five month's leave on full pay.

Write in first place with full particulars of birth, nationality, training and experience, to BOX FE/144, c/o 95, Bishopsgate, E.C.2.

E9095 A

MECHANICAL INSPECTING ENGINEERS with the necessary technical, manufacturing and operational experience required to deal with the Inspection and Test of Turbo-Alternators, Boilers and Ancillary Power Plant during all stages of manufacture from raw material to finished product. Training will be given to suitable applicants. Salary dependent on qualifications.—Applications to Merz and McLellan, Carliol House, Newcastle upon Tyne, 1. Reference " HEW." E9073 A

METHODS ENGINEER

We are seeking an engineer, aged 35–45, experienced in plant layout and flow production. This appointment offers many advantages, including participation in a worthwhile non-contributory pension scheme. If you feel you can meet our requirements, please send full particulars of your training and career to :

THE PERSONNEL MANAGER,
TUFNOL LTD.,
PERRY BARR, BIRMINGHAM 22B.
E2742 A

NUCLEAR ENGINEERING

DEVELOPMENT ENGINEERS required for work on novel projects connected with nuclear and conventional steam-generating plant.

Applicants should preferably hold a mechanical or Chemical Engineering Degree and should have some previous experience of the practical aspects in design or development of heat exchangers and high-pressure steam plant.

Commencing salary in range £900–£1200 per annum. Contributory Pension Scheme.

Application should be made in writing, giving details of age, qualifications and experience, to :

Staff Manager,
Foster Wheeler Limited,
3, Ixworth Place,
London, S.W.3.

E9035 A

RESIDENT CIVIL ENGINEERS.—Applications are invited for the undermentioned posts for the construction of a power station in the Middle East, commencing summer, 1960 :—

(1) RESIDENT CIVIL ENGINEER, salary £2500–£2750 per annum.

(2) TWO ASSISTANT R.E.'s (Civil), salaries £1800–£2000 per annum.

(3) CLERK OF WORKS (Civil), salary £1500–£1750 per annum.

Approximately 2-year contracts ; first-class passages, including wife and three children ; free furnished quarters ; free medical/dental treatment ; free insurance ; no local income tax.—Applications, with usual details, also religion and two referees, to Wilton and Bell, Consulting Engineers, Roman House, Cripplegate Buildings, London, E.C.2.

E2747 A

PROFESSIONAL ENGINEERS
are required at
ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL
for the DESIGN SECTION of the REACTOR SERVICES GROUP.

POSTS (A). The initial design of intricate EXPERIMENTAL RIGS and LOOPS associated with RESEARCH REACTORS. Design calculations to meet stringent conditions of temperature, pressure and irradiation. The work will involve : CLOSE LIAISON with SCIENTISTS to FORMULATE REQUIREMENTS, PREPARATION OF SPECIFICATIONS, SUPERVISION OF DESIGN and MANUFACTURE, and PREPARATION of DESIGN and OPERATING MANUALS. Engineering design experience of a high technical content is required.

POSTS (B). The DESIGN, DEVELOPMENT and MANUFACTURE of CONTROL and INSTRUMENTATION SYSTEMS for NUCLEAR REACTORS and ASSOCIATED EXPERIMENTAL EQUIPMENT. The work covers :

* NUCLEONIC and INDUSTRIAL INSTRUMENTATION
* CONTROL CIRCUITRY
* SERVO-MECHANISMS and LIGHT ELECTRO-MECHANICAL ENGINEERING.

A degree or equivalent in Engineering would be an advantage and general experience of all the above subjects*, plus specialised experience in one of them would be expected.

SALARY : Two ranges : £860 (at age 25) —£1340 p.a.; £1370–£1825 p.a.

Housing and contributory pension schemes.

Please send Postcard to the Group Recruitment Officer (1590/25), U.K.A.E.A. Atomic Energy Research Establishment, HARWELL, Didcot, Berks. E9050 A

SPECIAL PURPOSE DESIGN DRAUGHTSMAN

required for Research Engineering unit situated in North West London. Applicants should be over 25 years of age and will be required to show evidence of extensive practical experience coupled with the capability of developing new production techniques including automatic handling. Candidates should be qualified to at least H.N.C. standard. Salary in the range £1100 per annum or upwards, depending on ability and experience.

Applications will be treated in strict confidence, and should be made in writing to SP 1921, A.K. Advg., 212a, Shaftesbury Avenue, London, W.C.2. E9054 A

TECHNICAL ENGINEERING WRITER

is required by a large firm of component manufacturers in the Midlands dealing with the Automobile, Aircraft and General Engineering Industries. Must be a qualified engineer with journalistic experience, capable of producing technical descriptions of products and installations from information acquired direct from Drawing and Design Offices.

Applications in writing, stating age, experience, qualifications and salary.

Our Staff have already been notified of this vacancy.

BOX No. E9080, " The Engineer." A

TECHNICAL SALES ENGINEER required by leading Pump Manufacturers on their London Office Marine Sales Staff. Should have sales and sea experience, with knowledge of condensing, closed-feed systems and compressed air applications. Apply, stating qualifications and salary required.—BOX No. E9090, " The Engineer." A

THE BOWATER PAPER CORPORATION LIMITED, Engineering Division, require the services of a qualified POWER ENGINEER for technical duties in connection with Industrial Power Plant. The applicant should have practical experience in the operation of modern Boiler House and Turbine House equipment and the maintenance of High Pressure Plant. He should also be familiar with the calculations necessary for thermal cycle comparisons in connection with new projects. The qualifications required are Graduate or Corporate membership of the Institution of Mechanical Engineers or the Higher National Certificate in Engineering.—Applications, giving full details of qualifications, previous experience and salary required, should be addressed to The Chief Engineer, The Bowater Paper Corporation Limited, Engineering Division, Northfleet, Kent. E9113 A

THE HARPER PAPER GROUP, a rapidly expanding group of companies engaged in paper making, converting and merchanting, requires an ASSISTANT CHIEF ENGINEER for employment in the Blackburn area. Applicants, aged 28–40, must hold either Corporate Membership of the Institution of Mechanical Engineers or an Engineering Degree, and should preferably have served a recognised engineering apprenticeship or its equivalent. They must have a good general experience in installation and maintenance of modern machinery and plant used in the industry, and a knowledge of steam-raising plant and electrical services. The person appointed will be responsible to the Chief Engineer (who is an Executive Director of the Group) and will find the work arduous but rewarding. A commencing salary in the £1200–£1400 range is envisaged.—Applications in first instance to The Harper Paper Group Limited, Southport, Lancs. E9082 A

THE LUMMUS COMPANY LIMITED, IMPERIAL HOUSE,
80, Regent Street,
London, W.1.
Designing Engineers and Constructors for Industry,
invite applications for a
COST/PLANNING ENGINEER
for Mechanical and Civil Site work.

Applicants should be 25–35 years old and site experience would be an advantage. Salary very attractive, with permanent appointment for the right man.

Apply in writing to :—
THE PERSONNEL OFFICER.
E9085 A

THE MAKERS OF HOLLANDS TOFFEE require an ASSISTANT CHIEF ENGINEER. Applicants, aged 28–40, must hold either Corporate Membership of the Institution of Mechanical Engineers or an Engineering Degree, and should preferably have served a recognised engineering apprenticeship or its equivalent. They must have a wide engineering experience, including installation and maintenance of factory plant and services, and a knowledge of steam-raising plant and electrical services. The duties of the post also embrace design and manufacture of special-purpose equipment and experience in this field will accordingly be an advantage. The person appointed will be responsible to the Chief Engineer (for whom he will be expected to deputise when necessary) and will find the work arduous but rewarding. A commencing salary in the £1200–£1400 range is envisaged.—Write for application form to Personnel Manager, Arthur Holland, Southport, Lancs. E9081 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, " The Engineer." A

WORK ENGINEER holding qualification in Electrical and/or Mechanical Engineering. Responsibilities : maintenance building and engineering manufacturing plant ; also Safety Officer. Salary : £1200 per annum. Apply, stating qualifications and details of past experience.—BOX No. E2745, " The Engineer." A

WORKS MANAGER required for well-known Company in India, manufacturing diesel engines under licence, to take charge of complete production from foundry to final testing. Modern factory. Excellent Salary and free accommodation. Car provided. Two-year contract. Free Air travel.—BOX No. E8975, " The Engineer." A

T.I. (GROUP SERVICES) LIMITED
(The Service Company of the Tube Investments Group)

A number of vacancies are available in the Plant Development Department of the above company for experienced

DESIGN ENGINEERS

The work of the department includes a wide range of plant design, development of prototype machines, factory planning, progressing installation programmes, etc.

PROMOTION

Excellent opportunities exist for promotion to responsible positions in the manufacturing companies of the Group. Pension Scheme and Life Assurance Scheme. Social Club facilities.

Applications are invited from men 28-35 years of age with experience in the design of special purpose machines and having as a minimum qualification Higher National Certificate or the equivalent. They should be sent, giving full details of qualifications, experience, present salary, etc., to the

Personnel Manager,
T.I. (GROUP SERVICES) LIMITED,
Rocky Lane, Aston,
Birmingham, 6.
E9018 A

BRITISH *Enka* LIMITED

ENGINEERING DIVISION CONCERNED WITH MAN MADE FIBRES AND FILMS have vacancies for

SENIOR DRAUGHTSMEN

in the following departments :

MECHANICAL ● BUILDING

Chemical Works experience would be an advantage, and one of the appointments calls for experience of pipework for various services. The work involved is of a varied and interesting nature. Salaries up to £1000 according to age, experience and ability. Contributory Pension Scheme with facilities for transfer. Hours 9 a.m. to 5.30 p.m.

Applications, giving full details of qualifications and experience, to Personnel Manager,

BRITISH ENKA LIMITED,
AINTREE, LIVERPOOL, 9.
E9077 A

SITUATIONS VACANT

'ENGLISH ELECTRIC'

OFFERS OPPORTUNITIES TO:

MECHANICAL CHEMICAL & CIVIL ENGINEERS

These opportunities existing at all levels of seniority will appeal especially to men who have been successful in their initial design and development work and who feel that either their progress is restricted in their present position or they would welcome an opportunity of widening their experience in a new field.

If you are interested in investigating these opportunities we may be able to offer you, why not write to the address below giving details of your previous experience, age, qualifications and salary? Correspondence will be treated in strictest confidence. Alternatively you may care to call for

INFORMAL DISCUSSIONS

LONDON Thursday and Friday, 10th and 11th March, 6.0-7.30. Saturday, 12th March, 9.30-11.0. **Marconi House**

MANCHESTER Friday, 11th March, 6.0-7.30. Saturday, 12th March, 9.30-11.0. **Queens Hotel**

GLASGOW Friday, 11th March, 6.0-7.30. Saturday, 12th March, 9.30-11.0. **North British Hotel**

There is no need to make an appointment our representatives will be pleased to see you.

Correspondence should be addressed to

THE TECHNICAL STAFF OFFICER, CENTRAL PERSONNEL SERVICES, Marconi House, 336/7 Strand, London, W.C.2.

quoting reference E1850J.

A few of the vacancies are indicated below but many others exist and the Company is always prepared to accommodate promising men in their organisation—we welcome enquiries.

CHEMICAL ENGINEERS. To join a small team designing chemical processing plant for organic cooled reactors. Applications are expected from men with a good honours degree and aged 25-35. Experience in design of distillation and heat transfer equipment is desirable.

PRESSURE VESSEL ENGINEER. To be responsible for certain aspects of the design of the main gas circuit. Experience in design of vessels for the petroleum and chemical industries, or of steam plant with auxiliaries and piping, together with a knowledge of the principal codes and specifications is essential. Welding shop experience whilst desirable is not essential.

STRUCTURAL ENGINEER. To work on a variety of projects associated with the design of nuclear power stations (with particular reference to reactor buildings and the turbine hall). Applicants should have national certificates and preferably some experience of heavy industrial steel work projects.

GAS CIRCUIT ENGINEERS. To conceive the design of gas circuits and study the economic selection of components circulator drive systems and methods of gas flow. The duties could also cover analysis of local performance specification of engineering features and the behaviour of the system under fault conditions apart from general thermodynamic and aerodynamic problems.

These positions require men of honours degree calibre and experience in turbine or axial compression, thermodynamics and aerodynamics would be an advantage.

FUEL ELEMENT DESIGN ENGINEERS. To be responsible for the design of new fuel elements and the co-ordination of supporting development work. Experience in one or more of the following fields together with a good degree is desirable: heat transfer, aerodynamics, strength of materials (including plasticity and preferably metallurgy) or mechanical handling and component design. Applications from engineers with H.N.C. and particularly relevant experience would receive serious consideration.

POWER STATION ENGINEERS (MECHANICAL). To be responsible for the handling of project and contract work in connection with the conventional plant associated with power stations. These engineers must be capable of preparing specifications, the analysis of tenders and be prepared to accept responsibility for progressing work through the contract stage. A knowledge of the design of cooling water and general pipe work systems is required, a knowledge of thermodynamics together with corporate membership of the Institution of Mechanical Engineers is desirable.

CONSTRUCTIONAL PLANNING ENGINEERS. To be responsible for programming planning and co-ordinating construction work. Openings exist for both mechanical and electrical engineers who have had experience in a similar capacity on the construction of power stations or of heavy chemical plant.

MECHANICAL OR CHEMICAL ENGINEER. To develop schemes for the storage and supply of CO_2 to gas-cooled reactors and for auxiliary CO_2 circuits associated with the reactor.

Corporate membership of a senior Institution is required together with a knowledge of pipe stressing and design of gas pumping machinery.

BLOWER DESIGNERS. With experience in both performance and mechanical design of blowers. A degree or corporate membership of a senior institution is essential for these appointments.

HEATING & VENTILATING ENGINEER. To co-ordinate services in the reactor building. This will require liaison with internal specialist departments for the layout of small pipe runs, cable runs, and preparation of schedules for heating, ventilating and electric motors.

A.M.I.H.V.E. is desirable together with a knowledge of the heating and ventilating requirements for large buildings and familiarity with small pipe sizing and specification. Some knowledge of electrical engineering is desirable.

MECHANICAL HANDLING ENGINEER. To liaise with specialist departments within the group for the development of schemes for handling of spent fuel elements.

Corporate membership of a senior engineering institution is desirable, together with a heavy engineering background and a knowledge of mechanical handling and craneage. Some knowledge of water pumping and water/water heat exchangers would be useful.

DESIGN ENGINEERS (THEORETICAL). Mechanical, civil or chemical engineers who are interested in design problems associated with pressure vessels and structures, heat transfer and fluid mechanics (as applied to the cooling of large vessels), vibrations, bearing friction or the determination of temperature distribution in plant, would find interest in this sphere.

The nature of these problems would require men with an honours degree (or its equivalent) and the ability to think clearly.

PLANT DESIGNERS. With experience in the design of process plants for the chemical or allied industries, and who are capable of process and strength calculations. These appointments require men with an honours degree or corporate membership of a senior institution.

E9121 A

Classified Advts. continued on page 124

SITUATIONS VACANT

BICC

require a

GRADUATE PHYSICIST OR MECHANICAL ENGINEER

for the Pilot Plant at their factory at LEIGH, LANCS. The work concerns the development of new electric cables and processes and provides good opportunities for inventiveness and originality. Previous industrial experience not essential, but those with a practical approach to problems are desirable. Salary according to age and experience. Staff superannuation scheme in operation.

Written applications, stating age, experience and qualifications, should be addressed to :

Personnel Officer,
BRITISH INSULATED CALLENDER'S CABLES, LTD.,
Anchor Works, LEIGH, Lancs.

E9100 A

SITUATIONS VACANT

BRITISH *Enka* LIMITED

JUNIOR TEXTILE ENGINEER

to join team of engineers engaged on maintenance work. Minimum qualifications ; O.N.C. or similar Textile qualification. Preference will be given to Time Served Engineers who have some supervisory experience. This is a permanent and progressive appointment and will carry a good salary. Pension Scheme.

Applications, stating age, qualifications, experience, etc., should be addressed to Personnel Manager,

**BRITISH ENKA LIMITED,
AINTREE, LIVERPOOL, 9.**

E9076 A

SITUATIONS VACANT

HERBERT MORRIS LIMITED
Loughborough

have vacancies for

GENERAL MECHANICAL ENGINEERING DRAUGHTSMEN

who wish to join a mechanical handling company with a varied and interesting range of products. All applicants with sound engineering experience will be considered. Experience in mechanical handling would be an advantage.

Where necessary, assistance can be given with housing.

Interviews can be arranged to suit applicants' convenience.

Write particulars age, previous experience, and any qualifications, such as O.N.C., to the Personnel Manager.

E9068 A

HOWDEN

James Howden & Company, Limited, have vacancies for additional

PROJECTS ENGINEERS (ELECTRICAL)

to handle Contracts work in the Precipitator Section of their Technical Engineering Department. Essential qualifications are a Degree or H.N.C. in Electrical Engineering with good experience in industrial installation, Drawing Office and/or contracts engineering work. Duties cover preparation of tenders, and administration of contracts for large Electro Precipitator installations. Good general conditions of employment and salary according to age, qualifications and experience.—Applications should be sent to the Personnel Manager, Howden & Company Limited, 195, Scotland Street, Glasgow, C.5, giving full details of career to date.

E9067 A

The world's leading inventors and manufacturers of special-purpose precision machinery for the Tobacco Industry have opening in their London Drawing Office for :—

MECHANICAL DESIGNER

Applicant should be qualified Engineer, age 25-35, of sound practical experience and with original and inventive mind, receiving recognition in his present post on that account.

This opportunity is permanent and progressive and holds promise of absorbing work on most attractive terms.

Applications stating age, qualifications and experience, should be personally addressed in confidence to G. B. SALMON.

MOLINS MACHINE COMPANY LTD. · Evelyn Street · London, S.E.8

E9086 A

CHEMICO

Have vacancies for DESIGN AND DRAFTING personnel soundly experienced in any of the following fields:—

DESIGNERS & DRAFTSMEN

Plant Layout	**Piping arrangement**
Pressure Vessel	**Structural Steelwork**
R.C. Industrial Structures	**Checkers**

Employment will be in one of the most modern new office blocks in London's West End where excellent working conditions are available with scope for advancement in this American Company.

Please reply by mail giving full particulars to:—

D. GRIVE, Chief Draftsman (Ref. E),

**CHEMICAL CONSTRUCTION (G.B.) LIMITED,
9 Henrietta Place, LONDON, W1**

*(Subsidiary of
Chemical Construction Corporation, New York)*

Interviews arranged locally.

E9070 A

A National Electrical Service
Northern Electric

OFFERS

PROFESSIONAL TECHNICAL POSITIONS having JOB SECURITY

The Company, established in 1895 and the leader in the Communications field in Canada, has recruited technical personnel in the United Kingdom for more than seven years. In over 20 years no engineer or scientist has been laid off owing to recessions. Our continuing expansion now has created additional vacancies for professionally qualified engineers and scientists in the following fields :

TRANSISTOR DESIGN AND PRODUCTION

Experience desired on development, design or production of alloyed and diffused semiconductor devices.

TEST SET DESIGN

Experience required in design and development of test sets for complete range of telecommunication equipment *or* high voltage power cables.

INSTRUMENTATION AND ELECTRONIC MEASUREMENT

Experience required in these fields and/or pulse and microwave circuitry, transistor and diode parameter measurements, &c.

DESIGN AND DEVELOPMENT OF TELECOMMUNICATIONS SYSTEMS

Experience required in communications engineering, including carrier multiplex, data transmission, radio systems, &c.

PRODUCTION AND MANUFACTURING ENGINEERING

Professional engineers required experienced in determination of facilities and methods such as used in mass production of telecommunications apparatus and equipment.

Above positions are in Montreal and various centres in Ontario.

Interviews will be held in convenient centres in Great Britain during late March. Transportation allowance for successful applicants. All inquiries treated in confidence and acknowledged. Give full details of qualifications, experience, &c., in first letter to :

Dept. N.E.C.,
NATIONAL EMPLOYMENT SERVICE—CANADA,
61, Green Street, LONDON, W.1.

E9057 A

SITUATIONS VACANT

MECHANICAL ENGINEER

A large national Company has a vacancy for a Mechanical Engineer in each of the following centres :

Newcastle
Glasgow
Manchester
Wolverhampton

The Company is an expanding one and future prospects are very bright. The need is for good calibre men, aged 28-30, with experience in the heavy engineering or chemical fields. Candidates should preferably have at least a H.N.C. in Mechanical Engineering, or M.O.T. 1st Class Certificate (Steam and Diesel) supported by an engineering apprenticeship.—Please send brief details to BOX No. E9062, " The Engineer."

A

SITUATIONS VACANT

£7000 A YEAR

The advertising company will take you progressively to this figure if you are a university graduate, have at least five years' experience in production management, are about 30, have high personal qualities, and are successful in the work you will undertake.

Please send relevant details about above points, including current salary to Box No. E9094, " The Engineer."

A

MECHANICAL ENGINEERS

CHEMSTRAND LIMITED

invite applications to fill appointments as Area Engineers in the Fibre and Chemical Areas in their new " ACRILAN " Plant at Coleraine, Northern Ireland.

Area Engineers are responsible to the Maintenance Engineer for control of plant maintenance and improvements. These positions provide unusual opportunities to acquire first-class knowledge and experience of plant engineering in a major industry noted for its outstanding progress in the field of automation.

Applicants should be in the 25-35 age group, fully qualified as Mechanical Engineers, and with some industrial experience, preferably in the man-made fibres, chemical or petroleum industries. Qualifications in Chemical Engineering would be an advantage.

These are career appointments offering a generous starting salary. Pension and Life Assurance Schemes and other big Company benefits. Assistance will be given in joining at Coleraine and in finding housing in the locality.

Please reply in strict confidence with brief personal and career details and present salary to the
Staff Personnel Manager, Chemstrand Ltd.,
8 Waterloo Place, London, S.W.1., quoting reference M.E.1.

E9096 A

AIR PRODUCTS (G.B.) LTD.

have vacancies for

PROJECT MANAGER

A qualified Chemical or Mechanical Engineer with experience as Project Engineer in the chemical plant field. Experience in low temperature engineering is desirable but not essential.

DEVELOPMENT ENGINEER

A qualified Chemical or Mechanical Engineer for appraisal of new techniques, equipment design, the study of materials and preparation of standards, etc.—all associated with the design, construction and operation of low temperature plants.

STANDARDS ENGINEER

H.N.C. (Mech.) minimum, with experience as a Standards Engineer in the Chemical and Process Plant Industry. To originate and prepare engineering standards for use in the Design Department and other engineering facilities of the Company on request, and to develop these standards into a comprehensive manual on his own initiative. Must be able to develop fully design standards for all aspects of pressure vessel, piping and mechanical design for ferrous and non-ferrous applications. Experience of high pressure and high temperature systems is advantageous, together with a knowledge of valves and flange systems. Must possess leadership potential to develop a fully integrated Standards Group.

Write
PERSONNEL MANAGER,
49-50, POLAND STREET,
LONDON, W.1.

E9106 A

CENTRAL ELECTRICITY GENERATING BOARD

HEADQUARTERS DRAWING OFFICE

Applications are invited for the following appointments at **Bankside House, Sumner Street, S.E.1 :**

A. TWO SENIOR CIVIL ENGINEERING DESIGN DRAUGHTSMEN

With at least 5 years' experience on Reinforced Concrete design, some steelwork experience an advantage.

Commencing salary within the range £980-£1,080 p.a.

B. TWO SENIOR CIVIL ENGINEERING DRAUGHTSMEN

With at least 3 years' design experience.

Commencing salary within the range £830-£940 p.a.

Permanent pensionable appointments. Staff Restaurant. Sports and Social Club. Holiday arrangements honoured.

Applications in writing to, or application forms can be obtained from, the Personnel Officer, 24-30, Holborn, London, E.C.1. Envelopes should be marked " Confidential Ref. ENR/89."

E9053 A

AIR PRODUCTS (G.B.) LTD.

ENGINEERING MANAGER

A well qualified senior chemical or mechanical engineer is required to head our engineering department.

He will be responsible to the Managing Director for all the engineering activity of the Company which is engaged in the design, manufacture and erection of low temperature process plant for the chemical, gas and steel industries.

The activities of our well established Company are expanding rapidly. This vacancy offers, therefore, outstanding opportunities for the really ambitious executive engineer.

Applications will be treated confidentially and should be addressed to :

Personnel Manager,
AIR PRODUCTS (G.B.) LTD.,
St. Giles House, 49/50, Poland Street, London, W.1.

E9061 A

LARGE COVENTRY FIRM

require

HYDRAULIC

and

MECHANICAL ENGINEERS

Successful applicants will be required to supervise their project from drawing board, through development, to production. Excellent office conditions, superannuation scheme and welfare facilities. Write, stating full details of experience, age and qualifications, &c., to BOX No. E8972, " The Engineer."

A

Classified Advts. continued on page 126

SITUATIONS VACANT

ENGLISH ELECTRIC

AVIATION LIMITED

AIRCRAFT DIVISION · LYTHAM ST. ANNES

Now is the time to secure your future in the NEW AIRCRAFT INDUSTRY with responsibilities in developing the new generation of Civil Aircraft backed by extensive Military Contracts, including considerable development of the Lightning and the new T.S.R.2. There is probably a post with increased responsibilities for you in one of the following categories:—

MECHANICAL ENGINEERS

- Structural Design, Stress Analysis, Airworthiness.
- Internal Flow and heat transfer.
- Development of mechanical systems.
- Aeroelasticity.
- Development Engineers.
- Weight Control Engineers.

AERODYNAMICISTS & MATHEMATICIANS

- Flight Test engineers with a minimum qualification to H.N.C. level.
- Computer Programmers.
- Aerodynamicists for control stability and performance calculations.
- Fluid flow specialists.
- High speed wind tunnel engineers.

ELECTRICAL ENGINEERS

- Theoretical Design of aircraft electrical systems.
- Development of electrical components.
- Development of Automatic Flight Systems.
- Electronic Engineers for development of " one off " control systems.
- Electrical and Electronic technicians to operate comprehensive test rigs.

AIRCRAFT DESIGN DRAUGHTSMEN

- For these vacancies applicants must have 3 years' experience in an aircraft D.O. and be engaged on design work.
- Electrical installations.
- Engine equipment and control installations.
- Structural design and engine installation.
- Power controls.
- Mechanical design, e.g. undercarriage design, control boxes, escape facilities.
- Flight test instrumentation.

If you are interested in one of these subjects and would like to make an appointment to discuss these opportunities on an informal basis, we invite you to write in confidence to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2., quoting reference E 1716C; giving details of your qualifications and experience and indicating your particular interest.

Appointments will be arranged by the Aircraft Division to suit your convenience, and we will endeavour to meet you at a centre within easy access to your home.

All appointments will be permanent and pensionable, after a qualifying period, and assistance with removals and housing will be given in certain cases.

E9078 A

SITUATIONS VACANT

Vacancies exist for good

DESIGNER DRAUGHTSMEN

to work on the development of specialised machinery and plant appropriate to the Photographic Industry. Good conditions and remuneration are offered with prospects of appointment as Engineering Assistants to applicants possessing suitable qualifications and ability.—Write in the first instance to Chief Development Engineer, Ilford Limited, Ilford, Essex, giving full particulars of education and career.

E9093 A

DESIGN ENGINEER

required with experience of Charging and Defuelling Equipment, Fuel Element handling and shielding, in connection with Nuclear Projects.

Applicants with an Engineering Degree will be preferred, and full particulars stating age, qualifications and past experience should be sent to :

N.P.E.,
VICKERS-ARMSTRONGS (ENGINEERS), LTD.,
Naval Construction Works,
Barrow-in-Furness, Lancs.

E9074 A

SITUATIONS WANTED

SALES REPRESENTATIVE, negotiator with Civil Engineering and Building World, seeks change of position. Wide experience and contact with Consulting Civil Engineers, Structural Engineers, Architect, Government Departments and Railways, &c., throughout the United Kingdom and Eire. Known to be energetic and a pioneer.—BOX No. E2721, "The Engineer." B

STRUCTURAL WORKS MANAGER, shortly returning to U.K., requires employment. Experienced all types of steel fabrication. Anything considered, anywhere. Commissions in India or en route to U.K. also welcomed.—BOX No. E2741, "The Engineer." B

WORKS ENGINEER, B.Sc., A.M.I.E.E., A.M.I. Mech.E., under 45. Experienced heavy industrial maintenance, building. Requires change.—BOX No. E2743, "The Engineer." B

BUSINESS OPPORTUNITIES

LONG ESTABLISHED GERMAN EXPORTERS of steel mill products of every kind and description are anxious to build up business relations for sales in the U.K. to distributors and end users. Enquiries are at present invited for wire rods, rolled steel, cold rolled bright and dark annealed hoops and strips in open hearth and alloy qualities, cold rolled sheets, large size unassorted new plates, &c.

KARL KARTHAUS SOHN LEHRELL,
DUSSELDORF,
Malkastenstr. 7

E9050 O

REMPLOY SPONSORSHIP SCHEME

Send for details which show an attractive proposition to manufacturers.

Write to the Managing Director, Remploy, Ltd., 25-28, Buckingham Gate, S.W.1, or telephone VICtoria 6621 (12 lines). E9064 O

PATENTS

THE PROPRIETOR of British Patent No. 763,810, for "PLATFORM ELEVATOR," desires to enter into negotiations with a firm or firms for the Sale of the Patent, or for the grant of Licences thereunder.—Further particulars may be obtained from Marks and Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E9098 H

BUSINESSES & PREMISES

ENGINEERING BUSINESS FOR SALE in Northampton, including Valuable Machine Tools : Boring Turret and Centre Lathes, Millers, Grinders, &c. Premises (on Lease) approx. 3500 sq. ft., low rent. Price : £5000 or near.—Particulars from Shouler & Son, Auctioneers, 1, Norman Street, Melton Mowbray. Tel.: 3081. E2728 L

MECHANICAL ENGINEER, aged 34, requires sound Engineering business. Capital about £5000. —BOX No. E2748, "The Engineer." L

DRAWING & DESIGN SERVICE

SENIOR MECHANICAL ENGINEERING DESIGNER REQUIRES PRIVATE WORK. Can undertake to produce, on time, Layouts, Arrangements and Details of Conveyors, Chutes, Hoppers, Pipework, &c. An accurate job assured. Site measurements undertaken at week-ends if required.—BOX No. E2744, "The Engineer." S

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

GLOBAL INDUSTRIAL CONSULTANTS LTD.
SHEERWATER WOKING SURREY

EXPERTS *in the* DESIGN *and* MANUFACTURE *of special purpose* MACHINES.

INVITE YOUR ENQUIRIES

Telephone
WOKING 4680-4

E2723 MW

FOR HIRE

LATTICE STEEL ERECTION MASTS (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. E103 K

600
FORK LIFT TRUCKS FOR HIRE
Modern Machines Only
Diesel & Battery/Electric
Capacities 2000 lb–18,000 lb.
Contact your nearest Depot :

GEORGE COHEN,
SONS & CO. LTD.
WOOD LANE, LONDON, W.12.
(Shepherds Bush 2070)
And at Stanningley (Nr. Leeds) . Kingsbury (Nr. Tamworth) . Manchester . Glasgow Swansea . Newcastle . Belfast . Sheffield Southampton . Bath

E200 K

MOBILE LIFTING SERVICES.—Lump sum or Hire Rate Quoted for any Lifting Work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 3235. E168 K

MACHINERY Etc. WANTED

URGENTLY WANTED.—10 or 20 tons capacity portable or semi-portable ASPHALT PLANT.—Reply BOX No. E9060, "The Engineer." F

DOUBLE COLUMN VERTICAL BORING MILL. Minimum requirements 4ft. table, 5ft. swing, 3ft. 8in. height under cross rail, 32 r.p.m. top speed. A two-ram machine is required : one ram and mounting for second ram will be sufficient. A 5ft. Richards machine is preferred, but any machine up to this size will be considered.—Send full specification, including year of manufacture, condition and price, TUBES LTD., EAGLE WORKS KIRBY MUXLOE, Nr. LEICESTER. E9075 F

FOR SALE

"RHODES" PRESS BRAKE, Model 1036, for sale. Capacity 10ft. 6in. by 3/16in. thick. Pressure 150 tons. Stroke 3in. Distance between housings 8ft. 6in. Arranged motor drive 400/440/3/50. Bed and top beam of rolled steel sections.—F. J. Edwards Limited, 359, Euston Road, London, N.W.1 or 41, Water Street, Birmingham, 3. E9118 G

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb w.p.; reconditioned 8ft. 6in. down to 3ft. dia.; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Two Bellis & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors ; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised ; and several others of various makes and capacities.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p.

MOBILE ROAD CRANES.—10-ton Lorain lorry-mounted 30ft.-70ft. extendible jib ; 10-ton 33 R.B. track mounted, 40ft. jib ; 8½-ton Ransomes Diesel/Electric, 21ft. jib. 6-ton Coles Diesel/Electric, pneumatics, new 1948 (2) ; 6-ton Coles Diesel/Electric, solids ; 4-ton Coles Diesel/Electric, solids ; 1945 ; 4-ton Jones KL44, diesel, 1950 ; 3-ton Jones "Super 40" diesel, pneumatics (3).

OVERHEAD CRANES.—20/6-ton Vaughan 42ft. 3in. span, cab type (6) ; 20-ton King, 42ft. 3in. span, 400/3/50 ; 15-ton Booth, 37ft. span, 400/3/50 ; 15-ton Morris, 35ft. span, hand-operated ; 10-ton Morris, "Goliath," 40ft. span, 400/3/50 ; 10-ton Morris, 48ft. span, 36ft. lift ; 10-ton Vaughan, 23ft. 6in. span, 400/3/50 ; 10-ton Vaughan, 21ft. span, 44ft. lift ; Wharton 7½-ton, 25ft. span, 400/3/50 ; 5-ton Henderson, 24ft. 7in. span, 1946 ; 5-ton Morris, 58ft. span, hand-operated ; 5-ton King, 29ft. 3in. span, power hoist, hand travel ; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel ; 4-ton Morris, 19ft. span, 220V d.c. (3) ; 3-ton Adamson, 48ft. span, 400/3/50 ; 2-ton Morris, 18ft. span ; 2-ton Vaughan, 27ft. 6in. span, 2-motor ; majority of the above are unused.

DERRICK CRANES.—7-ton Anderson Grice, 100ft. jib, electric ; 7-ton Rushworth, hand, 30ft. jib ; 1½-ton Anderson Grice, hand, 40ft. jib ; 5-ton Butters Grabbing, 80ft. jib, electric.

RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib ; 10-ton Grafton 34ft. jib, diesel conversion ; 8-ton Wilson, steam, 35ft. jib ; 5-ton Grafton, 35ft. jib, diesel conversion ; 5-ton Smith, 50ft. jib (2).

LOCOS.—Fowler diesel, 150 h.p. (2) ; Barclay & Ruston 80/88 h.p. diesel ; Bagnall 14in. by 22in. (two oil-fired, one coal), Peckett, steam, 7in. by 12in., 1941 ; also 3 miles track, 24in. gauge, Bogies, Turnouts, &c.

STEEL PIPING.—50,000ft., 2in. Galvanised, new ; 60,000ft., 3in., black, new ; 5000ft., 8in. seamless ; 1000ft., 12in. seamless ; 500ft., 14in. seamless ; 400ft., 18in. riveted ; 280ft., 21in. o.d. welded flanged ; 3800ft., 21in. seamless flanged ; 500ft., 24in. riveted ; 1450ft., 27in. o.d. welded flanged ; 216ft., 48in. riveted ; 216ft., 60in. riveted.

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Edwards

SCRIVEN Geared 7-Roll Plate Straightening Machine, capacity 5/16in. thick, size of rollers 74in. long by 6½in. diameter, arranged motor drive 400/3/50, rolls arranged 5 on top and 4 on bottom alternate fashion, weight approximately 5 tons.

NEW BESCO 8ft. 4in. by 3/16in. Type HK, All Steel Undercrank Open End Production Power Guillotine of steel construction, arranged motor drive, automatic hold-down, adjustable front and back gauges.

SEDGWICK Motorised Press Brake, capacity 6ft. by 3/16in. mild steel, motorised for 440/3/50, fitted with a hand lever safety device and electrically operated brake, depth of gap 15in., bed 76in. by 4¼in., width between side frames 41in., stroke 3in., weight approximately 6 tons.

SCHULER Power Geared Open-Fronted, Inclinable, Cam Action, Double Action, Drawing Press with adjustable bed, spring balanced blankholder, with automatic ejector and vertical adjustment, punch stroke 11in., blankholder stroke 4½in., bed 24½in. by 14½in.

NEW STOELTING Pyramid Type Plate Bending Roller, motorised 400/440/3/50, capacity 10ft. wide by ¼in. mild steel, diameter of rollers, top, 9½in., bottom 7½in., drop-end bearing for removal of completed cylinders, support rollers to bottom rolls, reduction gearbox drive to bottom rolls, with multi-disc slipping clutches, motorised adjustment to top roller.

MASSEY 5-cwt. Pneumatic Power Hammer, overhanging type with slides, size of hammer 5 cwt., longest stroke 21in., weight approximately 6¼ tons.

BESCO Double-Geared Hand-Operated Universal Swing Beam Folding Machine, capacity 6ft. 2in. by ¼in. thick, lift of clamping beam 8in., smallest trunk round beam 8¼in. by 7¼in.

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600

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1000kW, 3·3kV, 3-phase, 50 cycles back pressure type STEAM TURBO-ALTERNATOR SET, incorporating turbine by Bellis & Morcom, speed 4500 r.p.m., steam pressure 195 p.s.i.g., 380 deg. F. temperature, exhausting against 15 lb. back pressure, direct-coupled through David Brown gearbox to alternator by Harland Engineering, with exciter. Set complete with standard accessories and switchgear.

750kW, 400 volts, 3-phase, 50 cycles back pressure type STEAM TURBO-ALTERNATOR SET by Metropolitan Vickers, incorporating turbine designed to work with steam at 485 p.s.i.g., 700 deg. F. temperature, exhausting to back pressures between 25 and 60 lb., direct-coupled to alternator, complete with switchgear.

2500kW, 440 volts, 3-phase, 50 cycles pass-out/condensing STEAM TURBO-ALTERNATOR SET by British Thomson-Houston, 255 p.s.i.g. initially, capable of extracting 55,000 lb. or more steam/hour at pressures up to 35 lb., turbine also designed to operate fully condensing and is complete with ancillaries and switchgear.

NEW/UNUSED 500kW, geared back pressure type STEAM TURBO-ALTERNATOR SET by Metropolitan Vickers, date 1956, capable of giving its full output when supplied with superheated steam at 200 p.s.i.g., exhausting against 20 lb. back pressure, turbine direct-coupled through gearbox to alternator wound for 400 volts, 3-phase, 50 cycles, 4-wire supply, speed 1500 r.p.m., with switchgear.

313kVA, 400 volts, 3-phase, 50 cycles STEAM ENGINE DRIVEN ALTERNATOR SET, incorporating compound engine by Bellis & Morcom, with H.P. cylinder 15½in. bore, L.P. cylinder 23in. bore by 11in. stroke, engine rated to develop 368 h.p. plus 15 per cent overload when supplied with dry saturated steam at 150 p.s.i.g., exhausting against 10 lb. back pressure, direct-coupled at 375 r.p.m. to alternator by Mather & Platt, with exciter and switchgear.

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SONS AND CO. LTD.
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STANNINGLEY, Nr. LEEDS.
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BIGWOOD TYPE PBC 4-ROLL MOTORISED PLATE BENDING AND STRAIGHTENING MACHINE for sale. Capacity 48in. by ¼in. Rollers 55½in. long by top, 9in. diameter, others 8in. diameter. Electrical equipment for 440/3/50. Power rise and fall to rollers through clutches. Swing out end bearing with self support to top roller.—Photo, &c., from F. J. Edwards Limited, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham, 3. E9115 G

Classified Advts. continued on page 128

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MODERN DESIGN HEAVY DUTY TYPE
CAB CONTROL, SUPPLY 400/440-3-50

5-ton capacity, 55ft. 3in. span, by CRAVEN BROS. Hoisting 60 f.p.m., cross travel 100 f.p.m., long. travel 100 f.p.m. Lift 25ft. (TWO AVAILABLE.)

5-ton capacity, 47ft. 1in. span, by CRAVEN BROS. Hoisting 60 f.p.m., cross travel 100 f.p.m., long. travel 100 f.p.m. Lift 25ft.

5-ton capacity, 48ft. span, by ANDERSON-GRICE. Hoisting 50 f.p.m., cross travel 100 f.p.m., long. travel 300 f.p.m. Lift 26ft. (TWO AVAILABLE.)

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47 tons—20ft. by 6ft. by $\frac{5}{8}$in. thick.
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M.S. FLATS
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M.S. ANGLES
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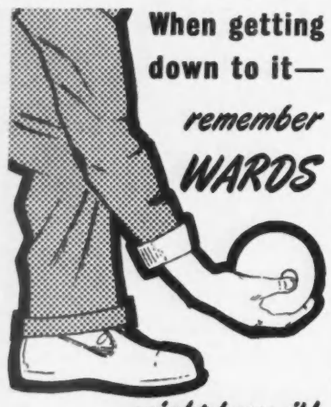

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2000kW pass out TURBO SET by Met.-Vickers, 250 lb. pressure, 250 deg. F., Reduction Gearbox and 2500kVA Alternator, 400/3/50, with control gear.
1000kW similar TURBO SET.
FOUR ECONOMIC BOILERS, each 12,500 lb. evaporation, 265 lb. working pressure, with Superheaters and Hodgkinson Stokers.
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FRED WATKINS (ENGINEERING) LTD.

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Fielding 200-ton ditto, 3ft. stroke, with pumps and motors (5 available).
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Two 26ft. by 4ft. Rotary Cooler or Dryers, with reduction gear and motor.

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SAMUEL PLATT MOTORISED DRAW BENCH for sale. Approximately 20ft. draw. Chain links $7\frac{1}{2}$in. by 2in. by $\frac{3}{4}$in. thick. Solid spacer $1\frac{1}{4}$in. thick. Diameter of chain pins $\frac{1}{4}$in. Electrical equipment suitable for 400/3/50. Worm gear reduction unit. Weight about 5 tons.—F. J. Edwards Limited, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham, 3. E9117 G

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FRORIEP KE10 40in., as above, max. swing 45in., speed range 3·6–180 r.p.m., h.p. motor 50. 1952 machine.

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E9053 G

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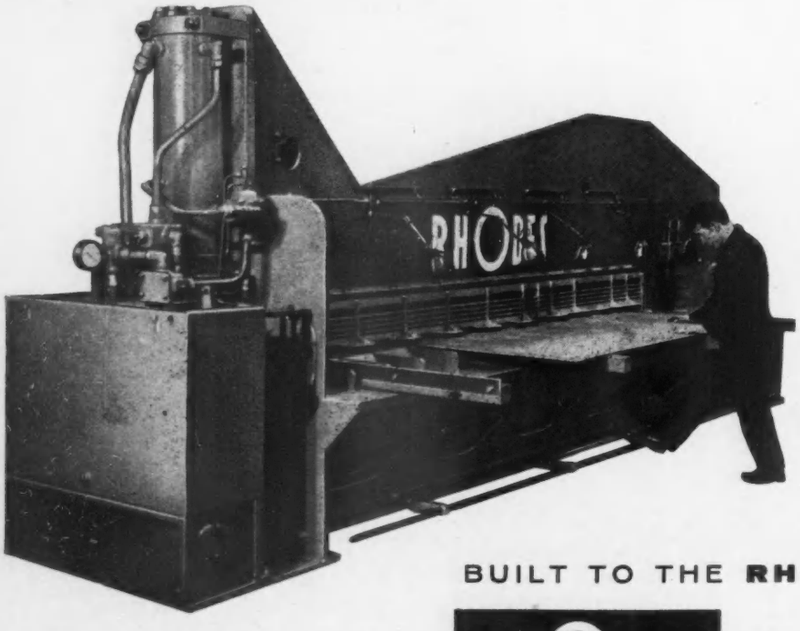

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234kVA, 400/440 volts, 3-phase, 50 cycles, 4-wire Diesel Engine Driven Alternator Set incorporating 269 h.p. vertical 8-cylinder engine by MIRRLEES BICKERTON & DAY, type UA.8, direct coupled at 500 r.p.m. to alternator by METROPOLITAN VICKERS, with exciter, set complete with standard ancillaries and switchgear.

225kVA, 380/420 volts, 3-phase, 50 cycles, 4-wire Diesel Engine Driven Alternator Set incorporating 262 h.p. vertical 5-cylinder engine by MIRRLEES BICKERTON & DAY, type TL.5, direct coupled at 600 r.p.m. to alternator by BRUSH ELECTRICAL, with exciter, set complete with standard ancillaries and switchgear.

180kVA, 400/440 volts, 3-phase, 50 cycles, 4-wire Diesel Engine Driven Alternator Set incorporating 210 h.p. vertical 3-cylinder engine by MIRRLEES BICKERTON & DAY, type J.3, direct coupled at 750 r.p.m. to alternator by BRUSH ELECTRICAL, with exciter, set complete with standard ancillaries and switchgear.

110kVA, 400/440 volts, 3-phase, 50 cycles, 4-wire Diesel Engine Driven Alternator Set incorporating 130 h.p. vertical 3-cylinder engine by MIRRLEES BICKERTON & DAY, type ULB.3, direct coupled at 600 r.p.m. to alternator by BRITISH THOMSON HOUSTON, with exciter, set complete with standard ancillaries and switchgear.

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NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft., and 30ft. wide huts ; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent. (Tel.: Bexleyheath 305). E113 o

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By Order of the Secretary of State for War

GOVERNMENT SURPLUS STORES

SALES BY AUCTION

		Main Location	*Auctioneers*
March 8–12	**Machine tools and miscellaneous stores,** including :—	M.O.A. Storage Depot, **Royal Arsenal, Woolwich, London, S.E.18.**	**FULLER, HORSEY, SONS & CASSELL** (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)
	Hydromatic and plain horizontal milling machines ; vertical, horizontal, rotary and spline milling machines ; universal grinders ; surface grinder ; cylindrical grinder ; S.S. and S.C. lathes ; capstan lathes ; drilling, slotting and shaping machines ; woodworking machinery ; 500 tons spares for electrical road rollers, generating sets, tar and bitumen distributors, stone crushers, refrigerators, cranes, Decauville locos ; concrete mixers and pumps ; trailer mounted diesel-electric generating sets ; asphalt mixers ; kerbside petrol pumps; fork lift trucks; builders', ironmongers' and electrical stores, insulated and electric cable ; copper wire ; 6500 field telephone sets ; binoculars ; radio stores and equipment ; 15,000 greatcoats ; 132 rolls 36in. green canvas ; clothing, etc.		
March 15–18	**Vehicles, earth moving and lifting equipment,** including :—	M.O.A. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
	1800 motor vehicles, trailers, motor cycles, etc., including 280 Saloons, limousines and estate cars by Austin, Ford, Hillman, Humber, Morris, Standard, Vauxhall and Wolseley (including 111 Ford Anglias, Populars and Morris Minors) ; Austin "Champs" ; Land Rovers ; Coaches ; Vans ; tippers ; other load carriers and dual purpose vehicles (many fitted with Diesel engines) ; trailers 10 cwts.–10 tons ; tankers 100 galls. to 2500 galls. ; excavators by Koehring and Ruston Bucyrus ; mobile cranes (some lorry-mounted) by A.E.C., Coles, Hyster, Jones, Lorain, Neals, Ransomes & Rapier ; crawler tractors, angledozers, and bulldozers by Caterpillar (including "D4's," "D7's," & "D8's"); scrapers; dumpers; Chaseside "Hi-Lift" shovels ; cable laying ploughs ; Aveling Barford road roller ; Bedford Lewin sweeper ; fitted mobile workshops ; trailer-mounted fire pumps ; wheeled tractors ; Stothert & Pitt Diesel cement mixer ; Holman trailer-mounted air compressor ; special Bedford 10-ton Diesel tractor ; 300 solo and combination motor cycles by Ariel, Douglas (Vespa), James, Matchless and Norton, plant ancillaries and spares by Caterpillar, Barber Greene, Bucyrus, General. Hyster, Jones, etc.		
March 15	**Miscellaneous stores.**	Central Ordnance Depot, **Didcot, Berks.**	**SIMMONS & SONS** (Dept. L), 12, Station Road, Reading, Berks. (Tel.: 54025.)
March 22–24	**Vehicles, machine tools and miscellaneous stores.**	Central Ordnance Depot, **Bicester, Oxon.**	**MIDLAND MARTS, LTD.** (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
March 30	**Miscellaneous stores.**	Northern Command Ordnance Sub - Depot, **Barlow, Nr. Selby, Yorks.**	**BARTLE & SON** (Dept. L), 50–52, Merrion Street, Leeds, 2. (Tel.: 2.0898.)
April 8	**Miscellaneous stores.**	Returned Stores Group, **Reed Hall, Colchester, Essex.**	**FENN, WRIGHT & CO.** (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 3171.)

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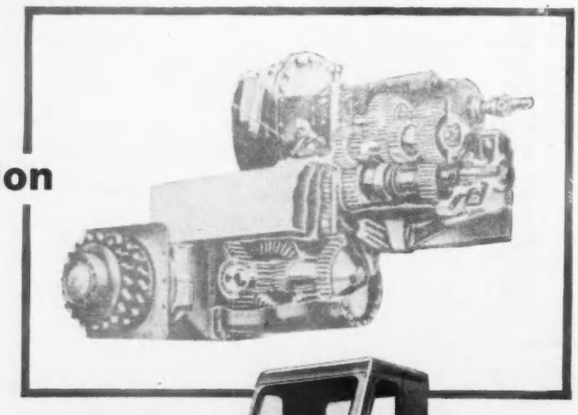

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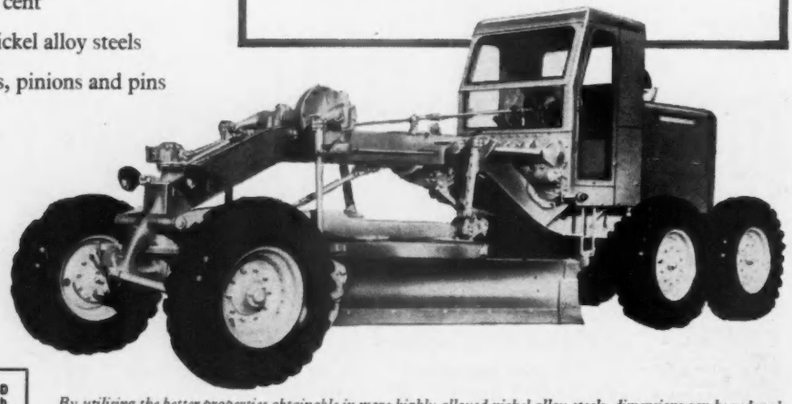

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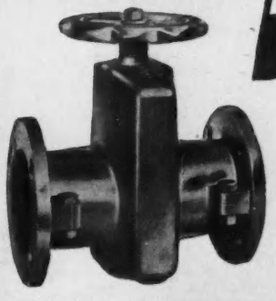

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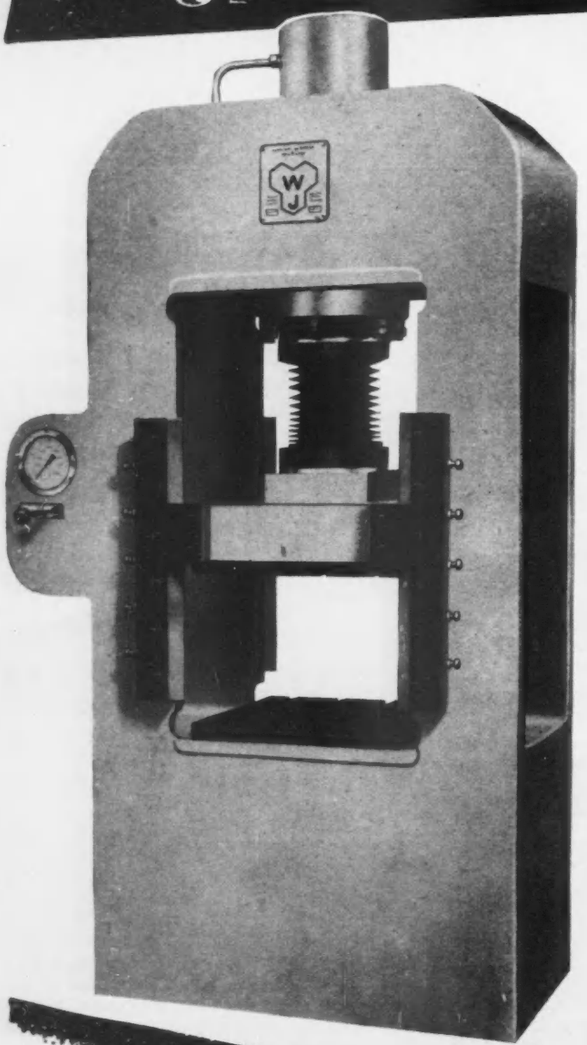

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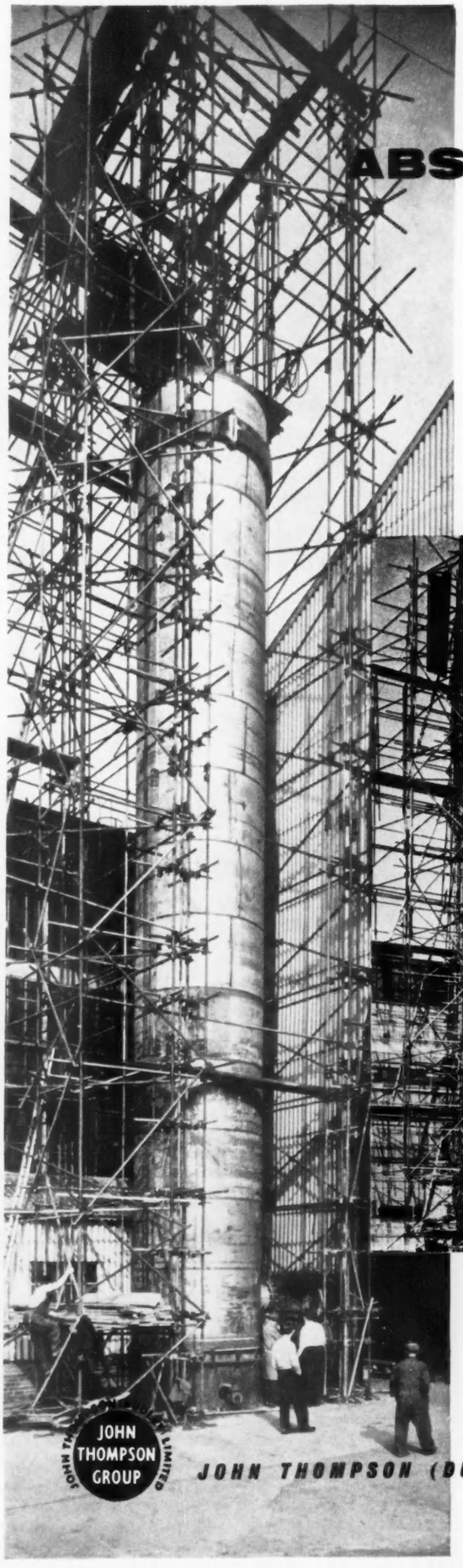

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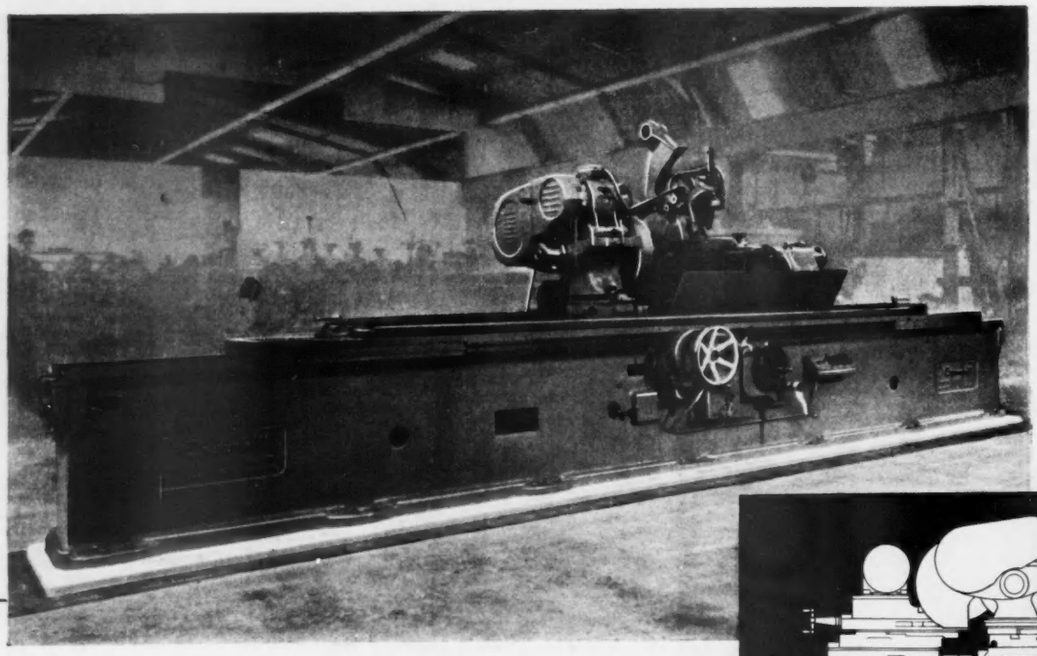

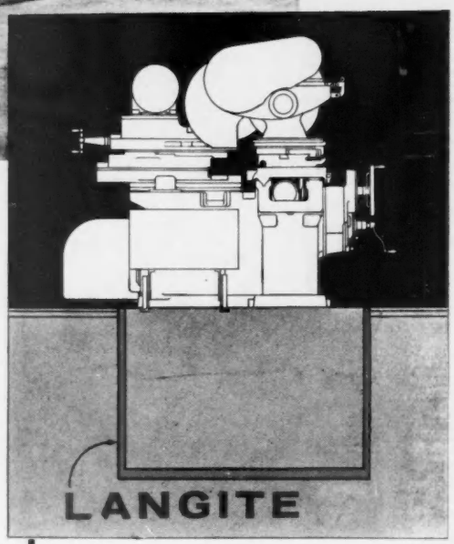

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